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ANNALS OF THE ASSOCIATION OF AMERICAN GEOGRAPHERS
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THE PROBLEM OF LAND CLASSIFICATION

CARL O. SAUER

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STATEMENT OF GENERAL PROBLEM.—In regional geography there are two leading questions to be answered: To what uses is the area in question being put; and: What are its possibilities? On these two questions the fundamental technique of regional analysis rests. If these primary objects are expressed in the study of rural areas there will first be studies in the present utilization of the land and thereafter, some sort of land classification.

In the former, the present condition of the land is under scrutiny, as to kind of use, productive returns of each type of use, and the effectiveness of kind of production as related to type of land. In this manner the area may be broken up into smaller parts, each characterized by a distinctive system of production, and usually differing in returns as well. In so far as this type of study can be expressed by a map, the map will reproduce the landscape as a mosaic of differing economic practices, usually, though not necessarily, closely related to different types of land.[1] Corn farming may be carried on on land of very different qualities and may show returns of the most contrasted kind. It may represent the best use for the several kinds of land, or it may be out of place. Land utilization studies are concerned first of all with the facts of present production. They then attempt to discover the conditions favoring and handicapping present production. They thus lead up to the consideration of incomplete use and maladjustment in use.

Beyond this stage of the inquiry lies the problem of classifying the land according to its future utility. What incorrect uses can be remedied; what intensification of use may be expected? We are here

[1] See article "Mapping the Utilization of the Land," *Geographical Review*, vol. viii, 47-54.

dealing with expectation of highest and most permanent return. Development looks into the future. Our present land systems are the expression of economic experience to which sometimes must be added unintelligent habit. Much of our present practice is not based on permanent return but on immediate return, or exploitation. *We desire to know for our lands the expectations of most permanent return under most complete utilization. Land classification therefore is a qualitative grouping of the land, considering the land as a permanent resource under a normally developing economic system.* It is an attempt to reduce a program of land development to a critical basis rather than to the optimistic basis which it now usually has.

Purposes of Land Classification.—There are two immediate objects to land classification: 1) to determine most appropriate use, or, type of utility, and, 2) to discover what returns may be expected in comparison with other lands, or, relative value. The two purposes are measurably distinct; yet we are largely interested in type of utility in order to know values. If the term "land valuation" is employed in a broad sense, it is land valuation that land classification attempts. The prices paid for land constitute in effect a sort of land classification, for they express in one form the idea of expectation of return. It is entirely inadequate to think of land prices as based on income. They are a thing much more complex than the classical tradition regarding them.[2] But because they are the result of many forces other than the average expectation of their utility, land prices alone do not constitute an effective classification. It remains nevertheless a matter of keen regret that we do not have a comprehensive national service for the gathering of statistics of land prices, which would constitute a most important body of evidence.

Productive Equivalence, the Basis of Classification.—In a developed area, expectation of future return, it is true, is guided largely by the performance of the land to date, and land classification will make full use of available data on production. Thus there has been employed in Germany for many years a system of land classification, called Bonitierung. In this land is grouped according to normal yields of staple crops, as we speak of land that will grow a bale of cotton or fifty bushels of corn to the acre. It is worthy of note that in this system judgment of quality is based on the normal performance of the land rather than on the results which an individual producer secures. The emphasis is placed on the land, not on the skill of farming, an important consideration in the equitable assessment of taxes. In the case of undeveloped land this aid to rating quality is

[2] Aereboe, Die Beurteilung von Landgütern.

of course lacking entirely. It is precisely this latter type of land that in this country is in urgent need of a workable classification.

If, then, land is to be classified according to quality, the classification will be by a series of groups, ranging from highest expected return to none at all, either present or potential. *Each group will consist of lands of nearly equivalent returns, but not necessarily of similar type of use.* For the area in question the highest class will be that of the most productive and most generally desirable lands. A set of standards may be worked out for what shall be considered Class One lands in Illinois, or Michigan, or Massachusetts. These will of course not be equivalents for all three states. Standards may also be set for the country as a whole and the classification of an individual area will then be on the basis of this larger standard. It is evident that the larger the area the more difficult the formulation of a usable set of standards. The lowest class is the only one that presents no difficulty; it defines itself in terms of no productive value of the land. The intermediate classes are determined by reference to the top and bottom of the classification. Such a quality classification is not a soil classification, nor is it a crop classification. Under ths system neither the soil nor the crop appear in the designation of the class. The designation of quality is expressed simply by a series of numbers.

Geographic Factors in Classification.—Desirability of land is determined in the main by factors that are distinctly geographic. They are not such entirely. Credit facilities, current rates of interest, security of title, the burden of taxation, amount and character of labor supply, organization of markets affect land values strongly, without affecting estimation of the quality of land. Transportation conditions are covered only partly by geographic factors. It may be said that the quality of land is determined by appraisal of its physical character, but into market value the considerations mentioned above also enter. These latter are the expression of stage of development.

Just what place stage of development should hold in a land classification is undetermined. It is undergoing almost constant, often rapid, and sometimes abrupt change. Possibly it can be represented sufficiently by a record of land prices. The immediate objects of land classification do not need to consider this element. We need to know land quality now most urgently for the large tracts of land that are undeveloped and for those tracts that are passing out of use. No one knows the extent of idle land in the country. The best-informed person in the South estimates the amount of idle land in that section at three hundred millions of acres.[3] The majority of this is cut-over land. In the Great Lakes states there are approximately forty million

[3] Ucker, in *Miss. Valley Mag.*, vol. II, no. 7, p. 10.

acres of cut-over and swamp lands. These are the lands for which a policy of use is needed and it is here that land classification encounters its great present-day problem.

If stage of development is disregarded, the productive value of land is expressed by the sum of the environmental conditions. These are: 1) the crop characteristics of the climate; especially length of growing season, distribution of sunshine and warmth through the growing season; likelihood of unseasonable frosts; amount of evaporation; amount, seasonal distribution, and variability of rainfall; snow cover; moisture stored over winter, and frequency of destructive storms; 2) soil characteristics with reference to the elements of fertility; ease of working; ground temperatures, and movement of soil water; 3) surface conditions; as to slope, relief, exposure (including local modifications of climate), and drainage; 4) water supply; 5) sizes of areas presenting uniform characteristics; 6) location in the economic and social sense, as affecting problems of production and residential desirability; and 7) the plant and animal environment. To the last item belong many considerations, only a few of which may be stated here. Stumps have constituted one of the greatest problems in American farm development. In the northern states pine stumps, especially white pine, remain a most serious obstacle to land clearing for many, many years. There is known as yet no generally profitable way for the removal of the stumps of a number of our conifers, and their resinous qualities make them proof against decay for long periods of years. Such lands present a difficult problem of use. Native, or introduced, plants and animals may compete so successfully with crops, or they may prey upon crops or stock, or they may affect health in such a manner, as to reduce seriously the desirability of farm lands, forest sites, or ranching, although the other conditions of the physical environment may be altogether favorable.

If these things must be taken into account in a land classification, the classification will need revision from time to time. It is one of the fundamental ideas of geography that the values of an environment are subject to change. One can hardly hope for a permanent classification. The significance of a body of land may be changed by soil erosion, by drainage or irrigation, by improved markets, by fire, by introduction of pests or the conquest of plant or animal enemies, and in many other ways. The economic situation in general may change through the demand for new types of products or the general depletion of others, as illustrated in the increasing value of timber lands. No land classification should attempt to forecast permanent optimum use of land, and in many cases it cannot fix permanently the quality class to which land is assigned. Its purpose is to work out a rational basis of development for a generation or two.

SYSTEM OF CLASSES.—Readjustments of classification will be reduced principally in two ways, by paying least attention to the most changeable factors, and by keeping the number of quality classes at the minimum. The German Bonitierung recognizes eight classes. The classification here proposed suggests seven.[4] All agricultural lands are put in classes One to Four, forest and grazing lands in classes Three to Six, and waste lands may occupy classes Six and Seven. It is assumed therefore that there may exist several uses for lands of the same quality class, and that the same body of land may have several equally good uses. In lands of intermediate grade agriculture has no exclusive claim. It is only in the upper grades that agriculture represents the highest use without question. Agriculture in itself is not the highest productive use of land; it is such only for certain lands.[5] There are farm lands at the margin of profitable return and lands below that margin. There are moreover agricultural lands above the agricultural margin that may be more profitably employed in other ways. Forest and grazing lands may not only be competitors on even terms, they may have a distinctly superior position with reference to farming. This classification therefore establishes *an overlapping stratification of use on the basis of economic equivalence.* In many cases there exists in practice a mixed use by farming, forest growth, and grazing, because the returns from one use do not show a clearly greater return than is secured from the others. In other cases one use is exchanged for another according to the temporary economic situation.[6]

Class One.—In Class One all conditions are highly favorable. Returns are to be expected at the highest level and there should be every possible assurance of the maintenance of returns at the maximum level. This is permanently first quality land. From the investment standpoint it will represent the most gilt-edged of all investments, representing a type of land that even neglect and abuse cannot ruin. It should have a climate and soil suited in superior measure to the growth of the most profitable and important staples of agriculture. In our interior states it is most commonly corn and clover land, or it grows sugar beets, tobacco, flax, or alfalfa as the dominant crop. It should grow a number of important staples well, including one of the better legumes, so that returns may be kept at the highest mark should the demand for one crop fall off. It must be adapted to successful crop rotation, and to live stock farming, by way of insurance of permanent fertility.

[4] See scheme of classification accompanying this paper (p. 12). See also Ricardo, Principles of Political Economy, on Rent.

[5] Roth, Forest Valuation, 135-141.

[6] The terms "agriculture" and "crops" are used in this paper in their restricted sense.

These requisites demand 1) a reasonably long growing season, freedom from drought and excessively wet weather in so far as both demands can be met by one climate, adequate moisture during the period of most active growth, and sunny weather for ripening the crop. 2) A strong and balanced soil is demanded, carrying an abundance of plant food with good lime content, and of good behavior in times of dry as well as wet weather. 3) Good drainage and freedom from destructive floods, and also safety from slope wash are demanded. 4) An adequate water supply for all farming needs must be assured. 5) The land should lie in large and compact bodies, so that it may develop adequate centers for its commercial needs and an ample social life. How large an area is needed in American rural districts to have sufficient market facilities and social development is not known, for relation of size of area to character of development has not as yet been made the object of inquiry. It seems that at least a township of productive land is required for a good rural community. The township high school is the very smallest unit of secondary education that has been able to maintain itself, and then only if there is an exceptionally large population. Consolidated schools may approximate the limits of a township in the size of their district. In many agricultural sections a township of land is not enough for the development of a good market town. It is generally possible to determine that land values are reduced because of poor markets and social handicaps, where there is a small, detached body of good soil. Good land in small tracts is very rarely as desirable as the same type of land in large compact bodies. 6) The economic location must be such that access to the great markets outside is satisfactory. 7) Finally there should be no serious problem to production arising from plant or animal pests. The result is Class One A, the ideal farming country, the standard to which other lands are referred. For the country at large the highest type is the heart of the corn belt.

Climate, soil, and drainage are the most important considerations of quality. They may be fully satisfactory, but the land may be deficient in regard to one of the other conditions, which may be called minor. The body of land may be undersized. The market problem may present permanent difficulties, as is the case usually where a great distance separates producing and consuming districts. If this deficiency is of the minor rather than the major order, the land belongs to a modified Class One and may be designated as One B.

By definition, Class One is to be land highly productive of several important crops and is to show the greatest security of return. There are areas in which some specialized product is grown with profits comparable to those of the highest farming of Class One, on soil that has little value for general farming. This situation is to be found especially in a number of our fruit and gardening sections. Where

an important region of this sort is fully established it may form a further sub-class (One-X). In such a case however achievement alone, not expectation, determines the classification, and the greatest caution is indicated. If the success is due simply to skillful individual management, the situation is entirely beyond the scope of land classification. If the industry in question has become so well established through market organization, or otherwise, that a highly positive advantage is derived from the mere fact of ownership of land in that locality, then a superior economic location is to be recorded. The proper attitude in examining such a condition may well be decidedly one of scepticism.

These successful specialized districts, usually horticultural in character, derive their importance ordinarily from a superior shipping location, or a peculiar condition of local climate, together with a proven organization of skilled producers. The soil is a very minor factor in most cases, the intensive tillage employed and the advantage of early maturity simply indicating lighter textured soils as more desirable. At this particular point there belongs a danger signal. The fact that land will grow strawberries successfully does not cause it to sell at the price of strawberry land and does not entitle it to advanced rating. We have tens of millions of acres that could be used for various types of garden production in so far as soil conditions are concerned, but which have no likelihood of such use. One of the greatest wrongs perpetrated in real estate operations is the sale of light lands on the basis of such intensive production. The capitalization of these lands at fancy figures is on the fictitious basis of the performance of successful truck growing districts on similar soil. Yet the similarity of the soil is the least important consideration. In view of the enormous surplus areas of lands of light texture the promotion of such a tract does not change its low intrinsic value. Even a highly successful trucking district is not to be considered coordinate with the best general farming regions because its position is less secure. The organization of growers may break down; increased transportation costs may cause the profits of the industry to disappear; a plant disease may appear that destroys the crop. If anything happens to cause the successful crop to lose some of its profitable character in any particular location the value of the district may be lost. It is not so with land that grows many things well. For this reason the necessity of alternative staple crops is emphasized for strictly first-class land.

Excepting One-X, land that is now first-class should give every assurance of remaining such, if it is to be rated as Class One. Lands of lower classification may be moved up into Class One under certain circumstances, as through drainage or irrigation. In such cases however the accomplished improvement is necessary. The best expectations

of drainage of a swamp or the irrigation of a desert leave the value of the tract still speculative. There are numerous illustrations of partial disappointment in most carefully planned reclamation projects. Demonstrated success alone can force favorable revision of the classification.

Class Two.—Class Two includes land less profitable than Class One, but still satisfactory farm land and distinctly better suited to farming use than to grazing or timber growing. Climatic conditions may be less favorable, as in our wheat belt, or the soil may be less productive. Here belong most of the heavy clays and the lighter loams, as well as soils of deficient or excessive organic content. Care in handling may be necessary to prevent soil erosion. The class will be determined largely by the elimination of Class One and the determination of the upper limits of Class Three. It is in this area that the majority of the farm land of southern Michigan lies, and probably as well the majority of farms the country over. It represents the reasonably good farming country, and, in its lower parts, the land that is only fair. It may be subdivided into two classes. The upper division will include for our interior states the typical wheat, barley, and oats land, the lower division the major areas planted to rye, potatoes, beans, and common hay. In this class there may be minor areas of non-arable surface, increasing in amount toward the lower limit of the class. With decreasing productive possibilities, hillsides and sandy or rocky patches may become more numerous. Unevenness of surface causes land of good soil and climatic conditions to go into this class. Where roughness of topography is a factor, fields tend to be smaller and more irregular in outline than in the superior group of lands, labor costs are higher, machine farming is less prominent, and operations in general are on a smaller scale. In the older farming districts of second grade land the use of artificial fertilizers is common if cash crops are grown. Under reasonable care however the permanence of farming use should be assured for all land in this group. If as the result of abuse, soil erosion or sand blows set in, or the land deteriorates in some other way, it is dropped down at least one class. Since very different causes may determine the placing of land in Class Two we may find it in very dissimilar areas: The small grain districts of the western part of our interior, the farms of the northern glaciated areas, the old soils of the South, the better farms of hill sections, mostly, through handicap of climate or soil or location, have their highest possible place in Class Two.

Class Three.—In Class Three agriculture no longer has unqualified prior claim to the land. Here belongs in the first place the marginal

farming land. It may be land from which a farmer of superior skill and energy can produce satisfactory returns, but on which the average farmer will do well in exceptional years only and in ordinary years will barely worry a living out of his farm. This land, in the long run, may give approximately as good returns under forest or grazing use. There is no definite highest use of the land determined, except as conditions of time and person determine it. The land may be best used now as farm land; a few years ago it may have yielded most as pasture; and in the near future may be given over to the growing of forests, or *vice versa*. In short, agricultural use, where present, does not enjoy the permanence of the higher classes. Northern Michigan has many farms of this class which are well worked, partially worked, or temporarily abandoned, according to the changing labor conditions that exist in the factories and mines.

The percentage of arable surface may be so low that a combined economy with grazing or wood cutting is imposed upon the owner of the land. In this case the fields are not sufficient to support the farm. Into these two divisions fall the lands on the dry margins of the country that are semipermanently farmed, the regions of summer frost damage, the lands on which continued cultivation makes ever more difficult the problem of maintaining soil fertility, and the areas in which continued cropping carries the threat of serious soil wash. In the eastern half of the United States probably the majority of the sandy lands, now farmed, belong in this class.

The class may also be thought of as embracing the lands for which there is good hope of drainage or irrigation, but not as yet reclaimed. It should embrace all those lands that may be farmed, but about which there is some doubt of their permanent use for farming. Here belong also the high grade forest and grazing lands, not only such tracts as may be converted to any one of the three productive uses of land, but also those that are good only for forests or for grass. It should contain the absolute grazing lands of good quality in the dryer and colder sections. It will contain also absolute forest land, of superior quality of site, in mountain and hill sections.

In summary, in this class agriculture, forestry, and grazing meet on fairly even terms for certain groups of land. Others belong exclusively to the ranch or the forest. Ideally, the average returns from any one use should approximate those from either of the other uses. *Where land of this class is undeveloped at present, it should not be recommended for agricultural development.* We have better lands, in large amounts, available in the superior classes. As long as that condition exists, it is an economic error to start farming on a basis of meagre return. For the present such lands should have the opportunity to grow at least one crop of timber.

SCHEME OF LAND CLASSIFICATION

Class	Agriculture	Grazing	Forest	Nonproductive
Ia	Permanently best cropland; can withstand abuse. Suitable for variety of staple crops. Approximates ideal conditions.	Only incidental or temporary.	Only incidental or temporary.	Not permanently.
Ib	Minor deficiency, as small size, deficient location.	do.	do.	do.
Ix	Highly successful specialized farming, without breadth of resources of Ia.	do.	do.	do.
IIa	Good agricultural land with satisfactory returns. Includes especially the major small grain lands.	Incidental to crop-farming.	do.	Very minor tracts of land not suited to production may be included.
IIb	Fair land, yielding sufficient returns so that it is occupied continuously for farming purposes. Especially small farming type.	do.	do.	
III a) b) c)	a) Marginal agriculture. b) Agricultural value probable but not proven. c) Land economy rests on necessity of farming joined with grazing, or forests, or both.	High grade.	High grade.	Minor areas of nonproductive land may be present.
IV a) b)	a) Submarginal farming. b) Any continued farming is destructive of the land.	Second grade.	Second grade.	do.
V	None.	Low grade, but commercially significant.	Low grade but commercially significant.	Waste land may form an important part of land area.
VI	None.	Emergency range.	Protective forests.	do.
VII	None.	None.	None.	All.

Class Four.—Agriculture in Class Four is out of place. Where carried on, it represents pauper farming or else a destructive use of the land. In the past few years tobacco has been grown with good immediate profits on rough limestone hills, but with the result that the clean cultivation of this crop has caused the soil to be eroded rapidly. Many of these old tobacco fields have been converted into sheep pastures. Cotton and corn are doing the same thing on many southern hillside farms. Where field cultivation destroys the land, agriculture is evidently out of place, and the land should be placed in a class below those that are agricultural. Where the returns of farming are persistently submarginal the land also falls into this class. We have in this country a fairly large agricultural population, so-called, that relies for a large part of its support on outside labor. Farm income studies in Michigan show a surprisingly large reliance on outside sources by the farmers living on the poorer lands of the northern part of the state. A variation of this condition is found in certain sections of the south, where standards of living are incredibly low, and in many cases still shrinking. Both of these groups constitute in effect pauper farming. To Class Four belongs the bulk of the country that should be our permanent forest and grazing land, now largely represented by cut-over lands and by our semi-arid regions.

Class Five.—Class Five represents low grade grazing and forest lands. The grazing lands furnish sheep rather than cattle pasture. The timber lands are occupied by trees of slow growth and often of low grade. These are the marginal areas for commercial grazing and timber production and are the result of rather unfavorable conditions of climate, soil, slope, drainage, and location. Michigan has this condition in her poor jack-pine plains and frosty, acid swamps. The sheep-country of the near-arid West and rather inaccessible timbered slopes of the western mountains furnish another illustration.

Class Six.—Class Six is below the margin of profitable commercial utilization. There is no longer intrinsic value to the land. The land however may still yield indirect returns. Although commercial forests may not be grown, protective forests of great importance may belong here. The protection of water sheds and fixing of dunes are two familiar illustrations. It is perhaps inappropriate to place any surface that is growing things, even though they are not marketed, into the same class as barrens. Class Six possibly can be that group of land that is not barren, yet has no direct productive value, present or future. Most land of this sort has a significance, some a high significance, in the control of drainage and for the preservation of our game.

Class Seven.—Class Seven is the permanently non-productive residue, the barrens of rock, sand, submergence, cold, aridity. Except for rare building site value, the land has no money value, unless it be for scenery. It may be an agreeable foil to the productive surfaces. The empty spaces may possess recreational values. From the standpoint of a quality classification we are concerned here simply with the fact that these areas are the permanent blanks in our studies of production.

Summary of System.—The sketch of a possible classification has been made in the present tense, in terms of return but it is concerned especially with the possibilities of the future. It is an attempt to formulate a classification in terms of minimum essentials. There are only two exclusively agricultural classes of land set apart (1, 2). Then follows the marginal agricultural land and the equivalent high grade forest and grass land (3). Next is the agricultural submargin and its parallel normal grass and forest land (4). It would seem impossible to cut down to less than these four classes. There must also be a class for low grade forest and grazing land of commercial possibilities (5). Classes Six and Seven might possibly be consolidated but there is an advantage to separating out the barren land from the land that is unproductive but not barren. Expectation of return may be based on an evaluation of the environment. Where little or no development has taken place the environment furnishes the only means for judging land.[7] It is these wild and wasted lands of our country that suggest the type of land classification here proposed.

Adaptation to Field Use.—This is not a working classification. It is a discussion of a problem. A complete scheme is offered to see whether the idea of classification, in order to determine equivalence of quality of land, actually fits conditions. Possibly a field classification can be derived from such a general plan. If so, it must be by experimental classification of land in limited areas, and preferably in areas that are undeveloped. It is possible that a scoring system may be devised for judging land. Why should it be more difficult to measure the possibilities of land than to determine the mental equipment of students? Educational measurements have not made unnecessary existing systems, but they have supplemented our information. If the crops and stock that land produces can be scored by individual standards of perfection, is it too much to hope that the land may be judged by something more definite than an unanalyzed impression of an untrained assessor? In truth, our largest land loan institutions,

[7] The other readily available means of approach, sale price, does not serve in this connection. Where there are large areas of wild land the price is very commonly no index of quality.

the insurance companies in particular, are trying out improved means of land valuation. A scoring system on the plan of this classification would rate land with ideal environmental conditions at 100. Possibly trial would show the feasibility of assigning a certain maximum number to each item of the environment, with penalties for particular handicaps. Scoring systems are not built a priori, but by the agreement of competent judges.

URGENT NATURE OF THE PROBLEM.—A land classification presupposes soil studies and a systematic utilization study of the area. It is most appropriately part of a geographic survey or an economic land survey. It is needed now in particular to help settle the problem of our idle lands. This idleness entails a continued economic loss which the country cannot tolerate indefinitely. Before these areas can be developed successfully it is desirable to know the purposes for which they are best suited. Trial by pioneer settlement is painfully slow and wasteful of human energies, and the correction of mistaken judgments is very costly. Pioneering was a less expensive matter in our national economy so long as there was an abundance of good land that could be brought under cultivation without unusual difficulties. The faith in pioneering still persists, but the readily available lands are largely gone. The bulk of the remaining land is low grade and the really good tracts are not receiving the attention that they should have. The present-day pioneer is drawn largely from groups that do not possess the land sense that characterized in general our earlier settlement. Failures are at an alarmingly high rate.

The idle lands essentially are not going back into forests because of the notion that farming development may appropriate them. Yet probably the majority of them are not suited to such use, at least in the near future. Meanwhile we are facing a forest famine of appalling proportions. A reforestation policy cannot be put into effect until the forester has sufficient tracts of land assigned to his use. Our depreciated western grazing lands are causing stock men to look increasingly towards the cut over lands of humid parts of the country, yet they have no reliable information to tell them where they can undertake grazing with good hope of success. All the while there is a large amount of energy misdirected into the temporary clearing up of low grade land, largely because there is no information to guide the stump settler. A land classification of cut over lands alone might supply the key for the reconstruction of an area larger than the corn belt.

Beyond this task is the possibility that land classification may help to bring order into our tax system. Taxation possibly should be based directly on sale price. In many sections sales are not sufficient to

enable such a basis. It may further find a place in the application of rural credits. It is of course invaluable as an essential part of the future discipline of regional economic studies. It is a worthy problem to which the attention of scientist and producer alike may well be directed.

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THE INCREASING IMPORTANCE OF THE PHYSICAL CONDITIONS IN DETERMINING THE UTILIZATION OF LAND FOR AGRICULTURAL AND FOREST PRODUCTION IN THE UNITED STATES

O. E. BAKER

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THE PHYSICAL FACTORS.—The physical factors or conditions determine in large degree the utilization of the land in a region; and these physical factors become more important as the population increases, the knowledge and practice of agriculture advances, transportation facilities are improved, and the supply of capital and labor is increased and better distributed,—in brief, as agriculture and forestry become more highly organized and commercialized. These physical factors can be classified into four groups:

1. Topography, or land form; i. e., the configuration of the earth's surface, degree and direction of slope, roughness or smoothness of the land.

2. Soils, including both physical structure and chemical and bacteriological characteristics.

3. Moisture conditions; i. e., rainfall, snowfall, hail, fog, humidity, rate of evaporation.

4. Temperature conditions, particularly growing season temperatures and dates of occurrence of spring and fall frosts.

In addition, there are two factors, physical in nature but of a different character from those mentioned above, namely location and size of area.

The moisture and temperature conditions relate primarily to the atmosphere, the topographic and soil conditions primarily to the surface of the lithosphere, or what is commonly called the land.[1] Moisture and temperature conditions jointly constitute the climatic factors; likewise topographic and soil conditions may be said to constitute the edaphic factors. The climatic factors, in the extent and permanence of their characteristics, may be compared to genera in botanical classifications; while the edaphic factors of slope and soil, owing to the local variability and lesser permanence of their characteristics, may be compared to species. The climatic factors influence in particular the development of the general system of farming,—dairying, cattle ranching, cotton growing, etc.; whereas the edaphic factors more often determine the best utilization for a particular piece of land,—whether it should be used for crops, pasture, or forest, and if suitable for crops, whether for wheat, potatoes, corn, etc.

The extent and importance of the climatic restrictions upon the use of land for crops are not commonly appreciated. A third of the area of the United States and of Asia, almost one-half of Africa, and fully two-thirds of Australia are unsuited to crop production because of deficient moisture; a half or more of Canada and of Siberia, because of deficient temperature. The climatic factors also affect the use of the land indirectly because of their influence upon the comfort and health of the people. The tropics, where half of the arable land of the world is located, are probably not suited to permanent occupation by the white race. The yellow race, however, appears to possess a wider climatic range of adaptation and is able to live, labor and reproduce in the tropics.

The restrictions upon the utilization of land due to topographic and soil conditions are less extensive and more localized. In the United States not over one-fifth of the land is too hilly or too rough for crop production, and a still smaller proportion is unfitted for farming because of deficient fertility from other causes than lack of water. But although fully two-thirds of the humid eastern portion of the United States is arable or reclaimable land, it is unlikely that all of this land will ever be utilized for crops; much will remain in permanent pasture and probably more in forest. Even in densely populated Germany and France only about half of the land area is classified as arable.

The Normal Order of Land Utilization.—In the humid, temperate portions of the United States the best land, that most fertile and easily cultivated, is commonly used for crops; the next best land, either

[1] But it must be remembered that this is a narrow use of the word "land," and that in law and often in economics the word "land" includes both the air above the surface of the earth and the minerals which may lie beneath.

because of hilly topography, deficient fertility, or excessive moisture, is used for grazing; and the poorest land, usually mountainous, stony, or sandy, is left in forest. Along the rivers, however, particularly in the southern states, potentially the very best land may remain in forest because it is subject to overflow, or is poorly drained; and in the northern states there are numerous small areas of muck (not peat) land, still in native grass or forest, which would be excellent crop land after drainage. In the semi-arid and arid portions of the western states the use of the land becomes largely a matter of water supply rather than of soil. These arid and semi-arid lands are mostly used for grazing cattle, sheep, and horses; but in the valleys and on the valley slopes, where water can be profitably diverted from the streams or pumped from wells, irrigation is practiced. Only a comparatively small area in southeastern California and southwestern Arizona is so arid as to have no agricultural use at all.

Even in the better grades of land, such as are suitable for crops, wide differences in usefulness and value are commonly recognized. These differences depend not only on variations in the moisture, temperature, topographic, and soil conditions, but also on the crops grown. For potatoes, for instance, particularly their commercial production, a sandy loam soil is preferred, and for sweet potatoes an even more sandy soil; whereas corn does best on silt loam rich in humus, wheat on silt loam lower in humus, and hay on rather heavy soils, such as clay loams. In general, however, the best land, such as level or gently rolling silt loam derived from limestone or loess, is good for all the staple farm crops. The acreage in potatoes, the various vegetables, and other commercial crops of more or less peculiar soil adaptation, outside the localities which specialize in them, is small compared with the acreage of corn, wheat, oats, hay, and other staple crops.

The Order of Land Utilization and Rent.—These differences in the inherent productivity of land give rise to the payment of rent. As Ricardo expresses it in his famous exposition of the subject,—

"If all land had the same properties, if it were unlimited in quantity and uniform in quality, no charge could be made for its use, unless where it possessed peculiar advantages of situation. It is only, then, because land is not unlimited in quantity and uniform in quality, and because in the progress of population, land of an inferior quality, or less advantageously situated, is called into cultivation, that rent is ever paid for the use of it. When in the progress of society, land of the second degree of fertility is taken into cultivation, rent immediately commences on that of the first quality, and the amount of that rent will depend on the difference in the quality of these two portions of land.

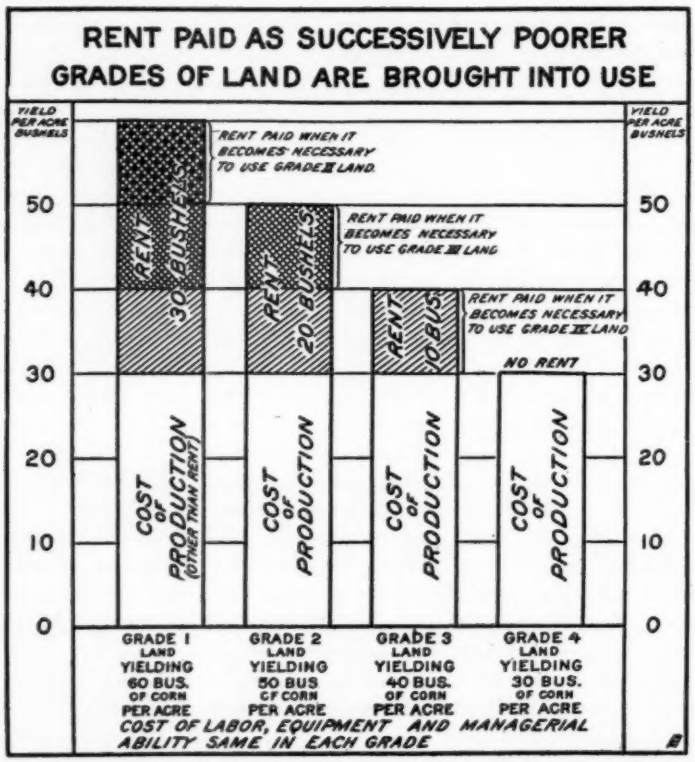
RENT PAID AS SUCCESSIVELY POORER GRADES OF LAND ARE BROUGHT INTO USE
YIELD PER ACRE BUSHELS
50
40
30
20
10
0
RENT 30 BUSHELS
RENT PAID WHEN IT BECOMES NECESSARY TO USE GRADE II LAND
RENT 20 BUSHELS
RENT PAID WHEN IT BECOMES NECESSARY TO USE GRADE III LAND
RENT 10 BUS
RENT PAID WHEN IT BECOMES NECESSARY TO USE GRADE IV LAND
NO RENT
COST OF PRODUCTION (OTHER THAN RENT)
COST OF PRODUCTION
COST OF PRODUCTION
COST OF PRODUCTION
GRADE 1 LAND YIELDING 60 BUS. OF CORN PER ACRE
GRADE 2 LAND YIELDING 50 BUS OF CORN PER ACRE
GRADE 3 LAND YIELDING 40 BUS. OF CORN PER ACRE
GRADE 4 LAND YIELDING 30 BUS. OF CORN PER ACRE
COST OF LABOR, EQUIPMENT AND MANAGERIAL ABILITY SAME IN EACH GRADE

FIG. 1.—Illustrating the Ricardian Theory of Rent. When grade II land was brought into use rent began on grade I, and if the 10 bushels paid as rent was worth $6.00, the land became worth, let us say, $100. When grade III land was used, although production increased only 36 per cent (assuming equal areas for the grades of land), the rent of grade I land doubled and its value became $200, while grade II land became worth $100, and the total amount of rent paid on all land, hence the value of all land, trebled. When grade IV land must be used, although production increases only 20 per cent, the value of grade I land rises to $300, of grade II land to $200, and of grade III land to $100; hence the total value of all land is doubled. In other words, as population increases and progressively poorer lands are brought into use, the value of land due to inherent superior quality increases much more rapidly than agricultural production,—from the standpoint of land values the geographic factors become increasingly important.

"When land of the third quality is taken into cultivation, rent immediately commences on the second, and it is regulated as before, by the difference in their productive powers. At the same time, the rent of the first quality will rise, for that must always be above the rent of the second, by the difference between the produce which they yield with a given quantity of capital and labor. With every step

in the progress of population, which shall oblige a country to have recourse to land of a worse quality, to enable it to raise its supply of food, rent, on all the more fertile land, will rise."[2]

The diagram (Fig. 1) illustrates the Ricardian theory of rent, and although the figures used are hypothetical they represent quite closely the situation in the Corn Belt as compared with adjacent areas of poorer land.

This explanation of land rent, made over a century ago, has found ample illustration in the agricultural development of the United States. At first settlement proceeded from the less fertile lands of the Atlantic states onto the more fertile lands of the Mississippi Valley, and as a consequence land values fell in the East. But as settlement then advanced into the sub-humid areas of the western states, land values rose again. In the more fertile portions of the United States this rise in value of farm land has been very rapid, in the Corn Belt the value per acre more than doubling between 1900 and 1910, and doubling again between 1910 and 1920. The values of poorer lands, on the other hand, have increased much more slowly, in New York, for instance, increasing 28 per cent from 1900 to 1910 and 12 per cent from 1910 to 1920.

This rapid rise in land values, and this increasing spread of the difference in value between excellent and poor or fair land, is owing primarily to the fact that population has increased more rapidly than the land supply. Land values have been more or less a compromise between present price of farm products and anticipated higher prices occasioned by increasing population, as shown in Figure 2. Since about 1896, when the price of food began to trend upward with increasing population, the rise in land values has been rapid. The decade 1890-1900 is a very significant period in American history, in that it marks the turning point in the relation of land supply to population. Since then not only has the acreage of improved land per capita of the population decreased, but also the new land brought into agricultural use is, in general, of a progressively poorer quality. It is notable how much more rapidly the excellent land of Iowa has risen in value than the poor-to-good land of New York. The low price of land in Iowa during the earlier decades, however, was largely owing to later settlement and lack of adequate transportation facilities. But the more rapid rise during the last three decades, as compared with New York, has been due principally to the greater surplus productivity of Iowa land available for payment of rent.

The Trend of Land Utilization.—The good land of the United States has been practically all brought now into agricultural use; that which

[2] Ricardo, David. Principles of Political Economy. Gonner Edition, pp. 46-47.

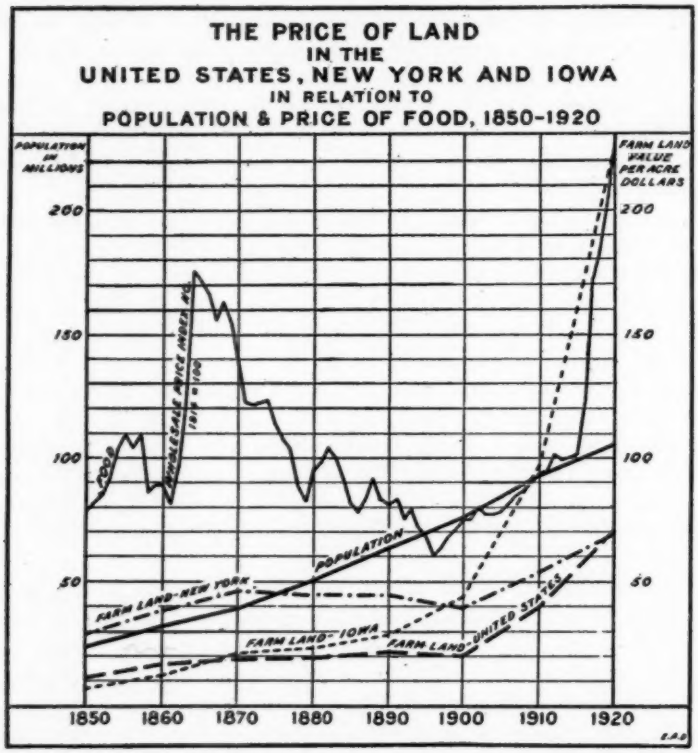

FIG. 2.—Statistics of the price of land and of population are from the Federal Census, of prices of food from the *Annalist*, New York, July 4, 1921, "The Long Time Trend of Prices in the United States," by Ralph S. Harlin, of the Russell Sage Foundation. It will be noted that the price of farm land for the United States as a whole remained practically stationary from 1870 to 1900, constituting a compromise between the declining prices of food products and the increasing population; but that since 1900 the price of land has risen more rapidly than population, and in the case of Iowa about as rapidly as the price of food. The more rapid increase in value of the excellent land of Iowa as compared with the poor to good land of New York is noteworthy.

remains unimproved is, with few exceptions, too wet or dry, too steep or stony or infertile for the profitable production of crops.[3] Indeed, the returns from the 1920 Census of agriculture indicate that the expansion of the farm area, particularly in the more hilly or less fertile

[3] The amount of such land which it is possible by various means of amelioration to bring into use for crops is probably over 300 million acres, or three-fifths of the present acreage of improved land. It includes about 75 million acres of drainable land and probably 30 million acres of irrigable land, which can be reclaimed when the price of farm products justifies the cost of reclamation. Also, there is perhaps

parts of the United States, has already proceeded farther than present conditions justify. The increase of land in farms between 1910 and 1920 was practically confined to the western half of the country, every state in the humid and longer settled eastern half showing a decrease, except Michigan, Wisconsin, and Minnesota, whose northern portions have been undergoing settlement, Missouri, whose Ozark Plateau is still in process of agricultural development, Arkansas and Florida, in which states large areas of land have been reclaimed by drainage.

Yet, despite the decrease of 12 million acres of farm land in the eastern half of the country, the area in crops increased 25 million acres. The trend during the decade was toward the more intensive use of the more fertile or favorably situated land, that is, its use for crops rather than pasture; and, apparently, toward the less intensive use of the less fertile land, that is, its use for unimproved pasture and forest. Increased production has been achieved by closer adaptation of the use of the land to the geographic conditions, and by greater concentration of labor and capital on the more productive lands.

The history of agriculture in the United States shows that with each advance in transportation facilities, in agricultural technique, and in economic organization, the correlation between the four physical factors (topography, soil, moisture, and temperature) and the use of the land has become closer. The control of geographic conditions over agricultural development, instead of being mitigated by the progress of science and invention, has been intensified and enforced. The commercialization of agriculture and the keen competition resulting between different regions makes the production of a crop sensitive even to the more minute advantages or disadvantages in geographic conditions which a district may possess, and compels shifts in crop production or in use of land to be made with an alacrity unknown in previous ages.

THE INCREASING IMPORTANCE OF TOPOGRAPHY.—The invention and extensive use in the United States of farm machinery, which is constantly becoming more efficient and essential to profitable crop production, has greatly increased the influence of topography in determining the utilization of land. Hilly regions, in addition to the former drawbacks, even under a hand-labor system of farming, of lesser accessibility as compared with level lands and consequently greater costs of marketing, also usually of shallower and less fertile soils, now suffer from the further disadvantage of being poorly adapted to the use of modern farm machinery. Certainly in the production of cereal crops,

175 million acres of forest and cut-over land not requiring drainage, but in many cases deficient in fertility, which will be suitable for crops after clearing; and a considerable area of stony or infertile pasture land in the East and potential dry-farming land in the West whose use for crops is not justifiable at present prices of agricultural products and labor.

and probably also of hay, one man can farm twice the area of level land that he can of hill land; and if the level land be more fertile, as is usually the case, the handicap of the hill-land farmer is further increased.

Illustration from New England.—Much rolling-to-hilly upland in New England, for instance, formerly used for crops and pasture is now in forest; while the level and more fertile bottom land of the Connecticut Valley, previously cropped with corn, grain and hay, is now devoted largely to tobacco, onions, and other vegetables, and is cultivated with an intensity unknown before.

The first step in enforcing the less intensive utilization of the hill lands and the more intensive utilization of the valley lands in New England was taken when the domestic, self-sufficing agriculture of the colonial and early national eras gave way to our modern commercial system of production. The transfer of industry from the home to the factory involved the transport of agricultural products from farm to city, and of manufactured products from city to farm, and in this transportation of commodities to and fro the more accessible, level, valley lands possessed a great advantage over the isolated farms in the hills.

The second stage in the gradual abandonment of the hill lands for crop production, especially of the steeper slopes, was ushered in by the introduction of elaborate farm machinery on the valley farms, but more particularly on the level lands of the rapidly developing western states. Prior to the Civil War many farmers in the hills of New England grew wheat for home consumption in little patches of two or three acres, seeded by hand, harvested with the sickle or cradle, threshed with the flail, and ground on shares at the local mill. But the competition of western grain, first from the Genesee Valley of New York and later from Ohio and Illinois, where farming machinery was extensively used, caused the gradual abandonment of these miniature wheat fields; so that since the Civil War New England farmers, as well as city folk, have been almost wholly dependent upon the West for their bread. Undoubtedly also the greater fertility of the lands in the West made competition by the hill farmers in small grain production practically impossible.

This western competition became possible only after the construction of the Erie Canal and the building of the railroads. These improvements in means of transportation, although preceding somewhat in time the invention of modern farm machinery, do not seem to have rendered western competition fully effective until some years after the Civil War. It was then that the Prairies and eastern portions of the Plains were most rapidly brought into use for crops, and the consequent contraction of the "improved" area in New England definitely

set in. From 1875 to 1885, and again from 1892 to 1898, the prices of farm products were particularly low and agriculture was declining in New England.

The latest stage in this economic evolution, dating from about the year 1900, is characterized by the more intensive use of the valley lands for the production of vegetables, city milk, and other bulky and perishable products which the rapidly increasing urban manufacturing population has required. These products cannot be grown so well on the hill lands because of the greater cost of transportation, and also because of the rougher topography and less fertile soil, while western competition is prohibited both by the great cost of transportation and by the perishable character of the products. The use of artificial fertilizer, and of animal manure from the cities, has greatly facilitated the development of this fourth stage in the agricultural history of the region. Unquestionably also the influx of Poles and other immigrants, accustomed to hand-labor and a low standard of living, has been an important factor in promoting the recent period of prosperity. Land in the Connecticut Valley suitable for onions has recently sold as high as $400 an acre, and rentals of $25 to $50 an acre are frequently paid.

IMPROVED AND UNIMPROVED LAND IN NEW ENGLAND, 1850 TO 1920

ACREAGE IN CROPS WITH ACREAGE RETURNS 1879-1919, AND VALUE OF ALL CROPS, 1899–1919

Year	Total Farm Land (Thousands of Acres)	Improved Land (Thousands of Acres)	Unimproved Land (Thousands of Acres)	Land in Crops (1) (Thousands of Acres)	Value of All Crops (Millions of Dollars)
1850	18,367	11,151	7,216	No figures	No figures
1860	20,111	12,216	7,895	" "	" "
1870	19,570	11,998	7,572	" "	" "
1880	21,484	13,148	8,336	5,215(2)	" "
1890	19,756	10,739	9,017	4,924	" "
1900	20,549	8,134	12,415	4,666	95
1910	19,715	7,255	12,460	4,422	141
1920	16,991	6,115	10,876	4,051	275

(1). Omitting fruits, vegetables, forage, and nursery products, statistics of which were not gathered until 1890 and 1900

(2). To which should be added an unknown acreage of permanent hay meadows.

The control of topographic conditions over agricultural development in New England, instead of being mitigated by the progress of science and the economic organization of agriculture and industry, has been intensified and enforced. It is significant also that the commercialization of agriculture and the introduction of farm machinery have raised the margin or general level of the utilization of land for crops, liberating the poorer hill lands for use for pasture or, more commonly, for forest. Agricultural production has not decreased materially in quantity, if at all, and has increased in value. The acreage of hay and

forage, for instance, which occupies 80 per cent of the crop land of New England, has decreased gradually since 1880 (the first census year for which figures of acreage are available), but the yield per acre has increased more rapidly than the acreage has decreased. Consequently, the production of hay and forage has shown an increase each census year except one, and in 1919 was 30 per cent greater than in 1879, as shown in the following table:

HAY AND FORAGE IN NEW ENGLAND

(Acreage, Production, and Value in Thousands; Federal Census)

	1879	1889	1899	1909	1919
Acreage	4,254	4,180	4,050	3,797	3,574
Production (Tons)	4,080	4,565	4,577	4,660	5,309
Yield per Acre "	.96	1.09	1.13	1.23	1.49*
Value	....	....	$43,662	$59,113	$108,946

* This increase in yield per acre is owing largely to increased use of forage crops, particularly corn silage and forage. In 1879 forage crops, apparently, were not included in the census figures; in 1899 they totaled only 103,268 acres, but in 1919 the area in the various forage crops amounted to 202,346 acres. The yields per acre of hay only were as follows: 1879=.96 ton; 1889=1.09; 1899=1.00; 1909=1.01; 1919=1.14 ton.

The Federal agricultural figures are available only by counties, and as all counties in New England include both hill and valley land (except Barnstable county, Mass., which is sandy), the Federal Census figures are not suitable for comparison of the trend in land utilization in the hill with that in the valley districts. Happily, however, the state of Massachusetts took a very complete census of its resources and production each decade from 1865 to 1905, tabulating the returns by towns (corresponding to townships in the West), and it is from these state census reports that the following figures are derived.

CHANGES IN THE USE OF LAND IN HILL[1] AND VALLEY[2] TOWNSHIPS, HAMPSHIRE COUNTY, MASSACHUSETTS

State Census Year	"Cultivated" Land (Crop Land) Acreage		"Unimproved" Land (Mostly Permanent Pasture)		Woodland in Farms Acreage	
	2 Valley Towns	4 Hill Towns	2 Valley Towns	4 Hill Towns	2 Valley Towns	4 Hill Towns
1865	9,031	10,689	6,393	28,000	2,969	10,357
1875	11,716	12,121	5,047	29,569	2,822	12,683
1885	11,941	12,000	5,514	28,628	4,496	18,403
1895	11,701	10,087	5,291	21,657	4,349	28,708
1905	12,156	10,787	4,084	22,506	6,491	35,884

[1] Chesterfield, Cummington, Huntington and Pelham.

[2] Hadley and Hatfield.

The acreage of "cultivated land" in the valley townships, it will be noted, was higher in 1905 than in any prior census year, indicating that slight extension of crop area has accompanied intensification of culture; while the acreage of "cultivated land" in the hill townships reached its high point in 1875, then declined to 1895 and afterward increased slightly to 1905, when it was practically the same as in 1865. For the state as a whole the amount of "cultivated land" increased from 1865 to 1905. On the other hand, the acreage of "improved" land, according to the Federal Census, both for Hampshire County and for Massachusetts as a whole, has declined constantly since 1880, and is now only about half what it was forty years ago. This apparent discrepancy between state and federal statistics is doubtless to be explained by differences in definition. "Cultivated land," according to the state census, includes land in crops only; whereas "improved land" of the Federal Census, at least in 1880, when a separation was made, included over twice as much "permanent meadows and pastures" as "tilled land and rotation grasses." Evidently, the decrease in "improved" land shown by the Federal Census has been due almost wholly to diminution of amount of improved pasture rather than to lessening area in crops. Much of this improved pasture has gradually reverted to unimproved pasture, and much of this unimproved pasture has, in turn, reverted to woodland. That this reversion to woodland has occurred more rapidly than the transformation of improved into unimproved pasture is indicated by the decrease in state census figures of "unimproved land." Woodland in farms more than doubled in extent during the forty years, 1865 to 1905, in the valley towns of Hampshire county, more than trebled in the hill towns, and nearly doubled in the state as a whole. A recent writer remarks concerning Massachusetts, "In the thirty years, 1880-1910, the forest was able to retake from the field half of the territory the hardy farmer had won, and has left the state only a little more than a million acres of improved land where formerly it had considerably more than two million."[4] This is true, apparently, if the words "retake from the field" are understood to refer to pasture.

The average value of farm land and buildings per acre in the four hill townships declined from $22 in 1865 to $18 in 1905, reaching a low point of $14 in 1895; and the average value in the two Connecticut Valley townships increased during the same period from $101 to $154, likewise marking a minimum of $85 in 1895.

In this connection it may be observed that fairly good soil is apparently worth much more than poor for forest and pasture as well as for crops, the ratio of value of valley to hill land remaining more or

[4] Showalter, William Joseph, "Massachusetts—Beehive of Industry." *Nat. Geog. Mag.*, March, 1920.

less constant for the forty years at about five to one for "cultivated land;" three or four to one for "unimproved land" (mostly pasture), and about two to one for "woodland." It is also significant that the value of agricultural products per person engaged in agriculture has throughout the forty years ranged from one-half to two-thirds as much in the hill towns as in the valley. This fact largely explains why the value of valley lands per acre should be so much higher than that of the hill lands, beginning at a ratio of about four and one-half to one in 1865, but rising to eight and one-half to one by 1905. The number of persons engaged in agriculture remained practically constant in both hill and valley towns during the 40 years. It should be noted that the figures of average annual value of agricultural products per person include a duplication of the value of the hay and oats fed to live stock, and also that expenditures for feed purchased, for rent or interest, etc., should be subtracted in order to arrive at the farmer's real income.

A farm management survey of a New Hampshire district, similar in character to the hill towns of Hampshire County, showed an average labor income of $256 in 1909. This is not a living wage, according to modern American standards, and these hill farms probably never have paid an income equal to that obtainable in either the valley farms or factories to-day. The reversion of these hill lands to forest is a blessing, not a misfortune; timber and forest products are as essential to the prosperity of the people as hay or grain. In Massachusetts some of the pine forests which have sprung up in old pastures since the Civil War are reported to be yielding to-day an average net annual income of $5 per acre.[5] The progress of invention and the regional competition of modern commercial agriculture are merely enforcing the control of geographic conditions and compelling these lands to be used more economically from the standpoint of human labor. It is probable that the fuller use of these hill lands for forest, by affording winter employment, will permit the cultivation of more farm land in summer than would otherwise be possible. Agriculture in New England has advanced not receded; the land is being utilized more efficiently and in general more profitably than ever before.

Illustrations from Other Hilly Sections.—The same trend toward less intensive utilization of hilly land, that is, for forest and pasture rather than crops, which is so characteristic of New England agriculture, can be seen in many other hilly or mountainous regions, though the trend is, in most cases, not so striking. The accompanying table provides figures from the last five census reports for four hill land counties as compared with four lowland and fairly level counties in New York, in Pennsylvania, in Virginia and West Virginia, in North Carolina,

[5] Letter from Mr. P. S. Lovejoy to the writer, 1921.

and in California. It will be noted that the approximate farm income in 1909 (the only year for which figures are available) was considerably higher in each group of lowland counties than in the corresponding group of hill land counties. In New York and Pennsylvania the acreage of improved land, also the "country population," in the hill land counties has declined notably since 1900. In the lowland counties improved land and population has also decreased, but at a much lesser rate. Value of land and buildings per acre since 1900 has increased about 65 per cent in the hill land counties, and in the lowland counties about 100 per cent.

In Virginia and West Virginia the acreage of improved land in both hill land and lowland counties, as well as "country" population, has remained almost constant since 1900, and the value of farm land in the two groups of counties has increased at about the same rate. The good showing of the hill counties in these states is probably owing to the considerable area of fertile limestone soils they include. In North Carolina the acreage of improved land in the hill counties has decreased markedly in the past decade, and although the value of land has advanced, the rate of increase is considerably less than in the lowland counties. Population in the hill land counties has decreased slightly and in the lowland counties has increased 5 per cent each decade. In California the decrease in improved land in the hill land (Sierra) counties has been notable, and has occurred to a less extent in the lowland (Great Valley) counties also, owing largely to the shift from grain growing to more intensive types of farming. "Country" population, accordingly, increased greatly in the lowland counties (50% in 20 years), whereas in the hill land counties it decreased nearly one-third.

The accompanying maps (Figures 3 and 4), showing decrease and increase in acreage of improved land between 1910 and 1920, reveal that the decrease occurred largely in districts of hilly topography, whereas the increase occurred principally in the Great Plains region, and on the Plateaus of Idaho and eastern Oregon and Washington. Here the broad, level bench-lands permit the use of large scale machinery, with a consequent cost of grain production per acre so low that it may be profitable to cultivate the land, with the summer fallow system, even though a crop is secured only in alternate years.

The Increasing Importance of Original Soil Fertility.—Inherently fertile land not only yields permanently a larger quantity of the staple farm crops than land less fertile, but also its capacity to utilize profitably the application of successive increments of capital and labor increases with its fertility. Because of this greater capacity to utilize capital and labor, as well as because of its greater produc-

THE TREND IN ACREAGE OF IMPROVED LAND, VALUE OF FARM LAND PER ACRE, AND NUMBER OF "COUNTRY POPULATION," FOUR HILL LAND AS COMPARED WITH FOUR LOWLAND COUNTIES IN FIVE STATES

State	Approximate Average Farm Income	Improved Land Total Acres (Thousands)					Value Per Acre of Farm Land and Buildings					Number of "Country" (Unincorporated) Population (in Thousands)		
	1909	1880	1890	1900	1910	1920	1880	1890	1900	1910	1920	1900	1910	1920
NEW YORK:														
4 Hill land counties*	$ 475.00	1770	1739	1730	1680	1447	$26.40	$28.90	$25.90	$33.10	$ 43.40	147	137	117
4 Lowland counties	797.00	1103	1073	1092	1096	1025	72.90	66.00	56.30	84.20	113.40	101	100	88
PENNSYLVANIA:														
4 Hill land counties	173.00	135	154	160	144	138	22.80	23.70	22.30	27.40	38.50	56	52	47
4 Lowland counties	670.00	1156	1165	1176	1173	1143	82.00	74.80	69.70	91.40	122.40	180	173	172
VIRGINIA AND WEST VIRGINIA:														
4 Hill land counties	474.00	268	313	377	342	360	7.30	8.00	8.90	14.30	28.70	35	34	33
4 Lowland counties	645.00	697	726	782	793	786	19.10	26.50	26.50	48.00	90.50	86	83	84
NORTH CAROLINA:														
4 Hill land counties	279.00	251	299	361	400	336	5.10	8.60	10.00	21.00	39.40	59	63	61
4 Lowland counties	381.00	479	514	559	601	558	7.20	8.90	9.20	21.00	45.20	90	95	100
CALIFORNIA:														
4 Hill land counties	471.00	205	213	164	157	139	9.00	13.80	9.60	14.80	23.40	31	27	22
4 Lowland counties	1125.00	1889	1856	1920	1784	1660	17.80	36.30	21.50	53.50	119.40	50	64	76

*The counties selected are as follows:

New York—Hill land—Cattaraugus, Delaware, Steuben, Sullivan.
Lowland—Livingston, Niagara, Orleans, Wayne.

Pennsylvania—Hill land—McKean, Cameron, Carbon, Pike.
Lowland—Adams, Green, Lancaster, Lehigh.

Virginia and West Virginia—Hill land—Alleghany, Highland, Va., and Hampshire, Pendleton, W. Va.
Lowland—Augusta, Botetourt, Frederick, Rockingham, Va.

North Carolina—Hill land—Ashe, Haywood, Macon, Mitchell.
Lowland—Davidson, Granville, Iredell, Union.

California—Hill land—Eldorado, Toulumne, Plumas, Nevada.
Lowland—Butte, Merced, San Joaquin, Yolo.

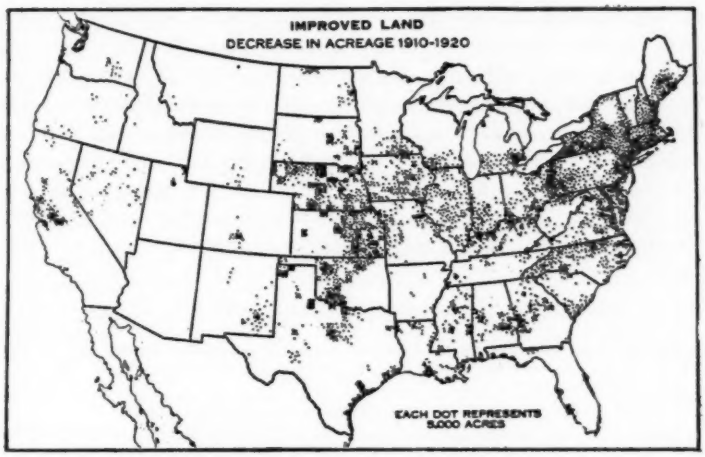

FIG. 3.—Decrease in acreage, 1910-1920

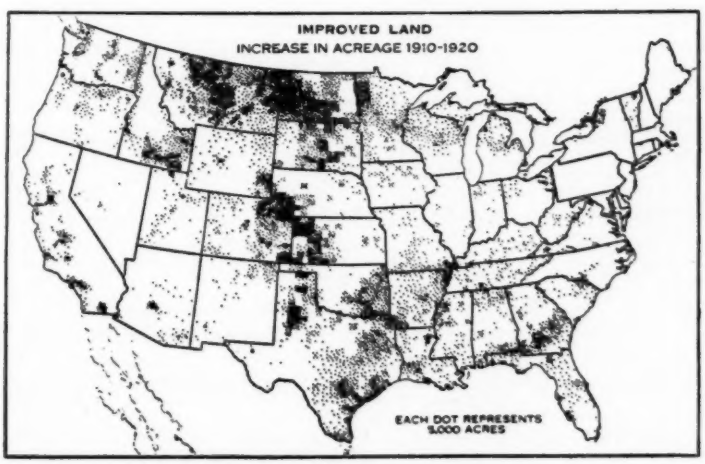

FIG. 4.—Increase in acreage, 1910-1920

tivity with the application of the same capital and labor, the best farm land has, in general, increased more rapidly in value than good farm land, good farm land more rapidly than fair land, and fair farm land more rapidly than poor land.

Illustrations from Ohio and Illinois.—In the following table the counties of Ohio and Illinois have been divided into four groups on the basis of decreasing value of farm land per acre in 1900, and it will be

noted that the increase in value of the best and good land during the following decades was not only much greater absolutely but also somewhat greater relatively than the increase in value of the poor land.

In thus grouping counties together on the basis of value of farm land per acre the effects of topographic conditions have been inevitably included with those of soil, but in these states the soil conditions are unquestionably of greater importance than the topographic, while climatic conditions in each state are sufficiently uniform as to have no material effect upon the value of land.

CHANGES IN VALUE OF FARM LAND PER ACRE

COUNTIES OF OHIO AND ILLINOIS CLASSIFIED INTO FOUR GROUPS ACCORDING TO VALUE IN 1900

	AVERAGE VALUE PER ACRE			
Ohio	First group of 22 counties of highest land value in 1900	Second group of 22 counties	Third group of 22 counties	Fourth group of 22 counties of lowest land values
1900	$ 51.30	$ 37.30	$ 28.90	$18.10
1910	82.60	65.60	45.10	23.70
1920	135.30	109.50	67.90	36.00
Increase in value 1900–10, Amount	$ 31.30	$ 28.30	$ 16.20	$ 5.60
Per Cent	61%	76%	56%	31%
Increase in value 1910–20, Amount*	$ 52.70	$ 43.90	$ 22.80	$12.30
Per Cent	64%	67%	51%	52%

	AVERAGE VALUE PER ACRE			
Illinois	First group of 25 counties having highest land value in 1900	Second group of 26 counties.	Third group of 25 counties.	Fourth group of 26 counties.
1900	$ 68.50	$ 50.50	$ 33.60	$19.00
1910	145.30	102.50	70.10	35.90
1920	259.60	180.80	114.40	50.60
Increase in value 1900–10 Amount	$ 76.80	$ 52.00	$ 36.50	$16.90
Per Cent	112%	103%	109%	89%
Increase in value 1910–20 Amount*	$114.30	$ 78.30	$ 44.30	$14.70
Per Cent	79%	76%	63%	41%

*The increase in value of the best land between 1910 and 1920 would be even more notable if the classification were based on value in 1910 instead of continuing to use the 1900 basis.

Illustration from the Upper Lakes Region.—The same forces which have caused good land in Ohio, Illinois, and in general throughout the United States to increase greatly in value and poor land to increase more slowly,—in fact, relative to the purchasing power of the dollar, actually to decrease materially in value in many localities,—has made unprofitable the clearing of much poor, or even fair, land in the northern portions of the Lake States. There are probably 10,000,000 acres of sandy or peat land in Michigan,[6] 5,000,000 acres in Wisconsin,[7] and about the same in Minnesota,[8] which under present economic conditions cannot be used profitably for crop production, but should, instead, be utilized for forests. Some of this land has already been cleared, often at heavy expense, farmed for a few years, and then abandoned. Not merely farms, but villages of several hundred people have been abandoned and have disappeared from the map. To quote from a recent government publication:

"I spent five days around Harrison and I saw abandoned farms in great numbers. I saw 100 farmhouses boarded up and desolate, and in some of them were the cook stoves, rocking chairs, and a lot of other stuff left behind, for they evidently had no money to cart it away. A whole lot of life's tragedy is written on the Michigan sand barrens. New settlers are going in right along to try the same old experiment of thrashing a living out of the sand and nothingness, and will meet with the same result."[9]

Undoubtedly much of this settlement on poor soils has been due to misrepresentation and fraud by land speculators and their agents. As an experienced farmer expressed it, "Of course you can farm these lands. All you need is two things—a shower of rain every week day and a shower of fertilizer on Sunday." But also undoubtedly a portion of the failures is to be attributed to the increasing productivity of the richer soils, both local and in other regions.

That the abandonment of these farms was not due to poor transportation facilities is evident from the fact that many of these unsuccessful farming areas are located directly on a railroad; and, that it was not due to climatic conditions, is shown by a survey made by the Federal Office of Farm Management in 1914 of 800 farms in northern Michigan, Wisconsin and Minnesota, most of which were located on

[6] Lovejoy, P. S. Farms vs. Forests. Twenty-first Annual Report, Michigan Academy of Science, 1919, p. 201.

[7] Estimated by the writer on basis of data furnished by W. J. Geib, of the Wisconsin Soil Survey.

[8] Estimated by the writer on basis of maps of Surface Formations of Minnesota, by Frank Leverett, contained in Bulletins 12, 13, and 14 of Minnesota Geological Survey (1915, 1917, 1919).

[9] Quoted by Dana, Samuel T. Forestry and Community Development: Bulletin No. 638, U. S. Dept. of Agriculture, 1918, p. 15.

the better soils of the region.[10] Fifty of these farms having between eighty and one hundred acres of tillable land, in addition to paying six per cent on the investment, gave an average labor income of $200, and those farmers having 180 acres tillable secured an average labor income of $500. The farmers having less than fifty acres, on the other hand, received no labor income, and did not even secure five per cent on their investment. Success or failure, therefore, on these better soils in the region depends on the amount of cleared land, which is in turn dependent largely on the amount of capital available. Dairying is the most profitable and is rapidly becoming the dominant type of farming, and dairy farmers having one hundred and twenty acres of tillable land obtained practically as large labor income as those averaging one hundred and eighty acres. Dairy farming in units of one hundred to one hundred twenty acres is a moderately intensive use of the land. Here, as elsewhere, the trend appears to be toward the more intensive utilization of the better land and the less intensive utilization of the poorer land.

It is fortunate that accompanying the increasing unprofitableness of utilizing the sandy lands for crops in this region is the prospect of an increasing profitableness of utilization for forest. The price of lumber is now such, and despite anything that can be done is likely to remain such for 50 years at least, as to warrant the protection of the young forests from fire in this region, and probably even the planting of some of the land to white or Norway pine, with the anticipation of a fair return upon the investment. If the pressure of population be so great fifty years hence as to exceed the limit of production of the better soils, it will then be fitting to consider the clearing and utilization of these sandy lands for crops; but meanwhile it should be recognized that every advance in agricultural technique and in transportation facilities, not only in the United States but even in Siberia or the tropics, tends to make the utilization of these poor soils for crops progressively more precarious, if not impossible.

Illustrations from California.—In semi-arid and arid, as well as in humid regions, the importance of original soil fertility is being increasingly recognized. Nearly all arid soils were formerly esteemed fertile, provided sufficient moisture was available, but the partial failure of some irrigated projects in the West, owing to sandy or otherwise infertile soils, has called attention to the fact that arid as well as humid soils vary greatly in their productivity. Moreover, the margin of utilization of land for crops appears to be rising in parts of the West just as it has risen in certain parts of the East. In California the trend

[10] McDowell, J. C., and Walker, W. B. Farming on the Cut-over lands of Michigan, Wisconsin and Minnesota: Bull. No. 425, U. S. Dept. of Agriculture, 1916, p. 9.

toward the more intensive use of the more fertile land and the less extensive use of the less fertile land has been exceptionally rapid.

Between 1899 and 1909 the acreage of wheat in that state declined from 2,683,000 to 478,000 acres, or over 2,200,000 acres. This decrease was distributed throughout every wheat producing county in the state except one, but was most marked in the San Joaquin and Sacramento valleys. Wheat had been extensively grown in these valleys for thirty years or more, in some localities almost continuously, yet there was no appreciable diminution in the average yield per acre for the state as a whole, according to the estimates of the Federal Bureau of Crop Estimates; nor did the price decline, but in the decade 1900-1909 increased nearly twenty per cent over that in the previous decade and equalled that in the decade 1880-89 when the acreage was increasing rapidly. In the absence of detailed statistics of wheat acreage to compare with soil types it seems reasonable to give credence to the popular and almost universal impression among farmers in that state that thirty years, more or less, of continuous cropping to wheat "wore out" the fertility of the poorer soils. As one Californian of wide experience remarked to the writer, "It was wheat, then barley, then rye, then good-bye." The persistence of wheat production on the better soils would account for the maintenance of the yield per acre.

This popular impression is supported by the use made, presumably, of the former wheat land. Only one-third of this land, apparently, has been used for crops, and two-thirds has reverted to pasture or remained unused. Rather one should say that there occurred between 1899 and 1909 a decrease in wheat acreage of 2,200,000 acres, and of rye and orchard fruits about 120,000 acres more; while during the same period hay and forage increased 294,000 acres, barley 166,000 acres, beans and peas 113,000 acres, grapes 28,000 acres, vegetables and potatoes 76,000 acres, various other crops 133,000 acres; thus showing a net decrease of crop land of 1,500,000 acres. The decrease in improved land was only 569,000 acres; so presumably over 900,000 acres of this former crop land reverted to improved pasture, of which there were nearly 3 million acres in 1910; and most of the remainder, or its equivalent of improved pasture, apparently reverted to unimproved pasture, of which there were over five and a half million acres in 1910. Unfortunately pasture figures are available only for 1910; so it is impossible to determine precisely how much of this former crop land became improved pasture, how much unimproved pasture, and how much went out of use altogether.

Illustrations from Kentucky.—The increasing importance of the peculiar suitability of certain soils for a particular crop is well illustrated by the production of white burley tobacco in the Blue Grass basin and

adjoining counties in Kentucky. In a study of the cost of production in 1919 it was found that the average yield per acre of tobacco on the good land in the central portion of the basin was three-fourths greater than on the less fertile land in Scott county. Moreover, the quality of the tobacco grown in the central district was better, the price received by fifty-three farmers averaging sixty cents per pound, while that from the twenty-eight farms studied in Scott county brought only an average of thirty-eight cents. The cost of production per acre other than rent was only ten per cent greater in the central district than in Scott county; indeed, the hours of horse labor per acre required in the central district was twenty per cent less and of man labor only three per cent more than in Scott county, but the wages paid were somewhat higher. The average value of tobacco land in 15 of the central district farms was $320 per acre, in 10 Scott county farms $85. The average share rent (one-half) in 1919 amounted to more than the value of the land,—$406 on 33 farms in the central district and $135 on 14 farms in Scott county. The average cash rent was $102 in the central district and $52 in Scott county. This seems very high rent, but the price of tobacco was extraordinarily high, and, moreover, only good land can be profitably utilized for burley tobacco, land inherently fertile and free from root rot. Land not suitable for tobacco seldom rents for more than $20 an acre.

The introduction of tobacco, therefore, into the Blue Grass basin, a crop requiring much more intensive use of the land than the corn, wheat, and pasture system of farming previously followed, has not diminished but instead has greatly increased the previously existing differences in both the gross and net productivity of the land. The rent of poor land in 1919 was little greater than before the introduction of tobacco; the rent of the best land had increased ten fold. Here, as elsewhere, increasing intensity of cultivation has raised the value of inherently fertile land more rapidly than that of less fertile land, both absolutely and proportionately.

The Increasing Importance of the Moisture Factors.—The development of modern agricultural machinery,—which has greatly increased the acreage of crops that a man can handle, especially of the small grains,—the increasing knowledge of dry-farming practices, and the breeding of drought resistant varieties of plants, particularly wheat, has extended notably the area available for crop production in the United States. But in the semi-arid areas of the West the small grains are soon found to be precarious crops, and the necessity of diversification and the adoption of systems of farming better adapted to the fluctuating seasonal conditions become apparent. Consequently, the adaptation of the varying soils and sites to different uses, especially with reference

to moisture conditions and requirements, is being studied in more and more detail. Provision is now more frequently made to irrigate part of the valley bottoms by means of flood water, or otherwise, in order to obtain hay or forage for winter feed; and it is becoming recognized that only dark brown, level land on the higher benches, where the rainfall is a little heavier, should be plowed up and put into "dry land" crops, all other non-irrigable land remaining in native pasture. In other words, as competition for the use of the land becomes keener and arid agriculture, like humid, becomes more commercialized, as the better lands rise in value and their productivity must be increased, it becomes necessary to fit the use of the land to the moisture conditions with more and more care and precision.

Formerly most of the semi-arid portion of the United States consisted of unfenced grassy plains, often intermixed with brush and flowering plants, grazed by roaming herds of cattle or bands of sheep. But now conditions are rapidly changing. Homesteaders have settled on most of the land that affords any promise of ever being fit for crop production; in some places succeeding in developing a farm, or selling to farmers who can succeed, usually by more intensive culture; in other and usually drier places selling out to stockmen who allow the fields that have been plowed up to revert to the native pasture grasses. Hence, in the semi-arid region, as elsewhere in the United States, the trend is toward the more intensive utilization of the better, in this case the moister land, and the less intensive utilization of the poorer land.

Illustrations from Montana.—This trend is particularly noticeable in Eastern and Central Montana. The wave of homesteaders that swept onto the semi-arid plains of this state during the wet years 1915 and 1916 may be separated into two sections: that which moved into the drier parts of Richland, Dawson, Blaine, Hill, and Toole counties in particular is slowly disappearing, and many of the young men and women are moving onto the irrigated lands and into the villages and cities scattered along the river valleys, or else are returning east. The abandoned land is being bought up mostly by cattlemen, some is reverting to the government, other tracts to the state for taxes, while the old fields are growing wild sunflowers or Russian thistles, and will eventually be reclaimed by the native pasture grasses. The other stream of migration which moved into the counties in the northeastern corner of the state is, in part, succeeding and is transforming the "open range" into fenced farms with cultivated fields and improved pastures. The difference between success and failure is measured by only two or three inches of average annual precipitation.

Illustrations from New England and the Gulf Coast.—The use of land for the production of certain crops may be limited by

excessive as well as by deficient moisture. Thus, in New England, wheat was formerly grown in much greater quantity than to-day, prior to 1830 probably in sufficient amount to supply local needs. But the moist climate made it particularly susceptible to fungous diseases, the agricultural periodicals and reports of the first half of the nineteenth century containing frequent references to "blight" and mildew. In order to stimulate production Massachusetts offered a bounty of eight cents a bushel in 1838, without appreciable result. Consequently, as soon as western New York was settled and the drier Genesee Valley was able to ship wheat and flour eastward by way of the Erie canal, the production in New England gradually declined, until to-day the amount of wheat raised in New England is insignificant. Seventy per cent of the wheat in the United States is now grown in regions having less than thirty inches average annual precipitation.

Similarly, cotton can be grown along the Gulf Coast of Florida, Mississippi, and Texas, but its commercial production in this coastal belt has been found to be unprofitable largely because of the heavier autumn rainfall, which not only interferes frequently with the picking of the crop but also may discolor and damage the lint. Cotton in the coastal belt, therefore, has been replaced very largely by winter vegetables, including both white and sweet potatoes, by velvet beans, peanuts, and sub-tropical fruits. Under the severe conditions of competition which characterize modern commercial agriculture, both between regions and between the crops and systems of farming within a region, it requires only a slight natural advantage, or disadvantage, to force one region out of and another into the production of a crop, or one crop off and another crop onto the land.

The Increasing Importance of the Temperature Factors.—The increasing influence of temperature conditions in determining the utilization of the land, as agriculture becomes more highly developed and commercialized, may also be illustrated by the changes that have taken place in the geographic distribution of cotton production, in this instance along the northern border of the Cotton Belt.

Illustrations from the Cotton Belt and the Commercial Apple Areas.—Cotton is the most important "cash" crop, that is, crop grown directly for sale, in the United States; almost none is now consumed on the farm. In the domestic, self-sufficing economy of the colonial and early national eras it was produced as far north as Washington, D. C., and St. Louis, Missouri, and even yet in the isolated valleys of the Kentucky mountains a few acres are grown by the mountaineers to mix with their wool in the weaving of homespun. But as cotton production became commercialized the price declined, and it gradually

became apparent that the cost of production was less where the summer temperature was higher and the growing season longer. So the northern margin of production slowly receded until it stands now at Norfolk, Virginia, and Cairo, Illinois, or, to be more general, at the line of 77° mean summer temperature and 200 days average duration of season from frost to frost. The close correspondence between this length of growing season line and the geographic distribution of cotton acreage is shown in the accompanying map (Fig. 5).

This increasing sensitiveness to geographic conditions with economic progress is further illustrated in the shift in production of the fruits. Apples, for instance, were formerly grown and sold by a large proportion of the farmers in the northern and eastern states, but now the commercial crop is grown mostly in large orchards favorably situated with reference to frost protection, sunshine, and other geographic conditions. Forty per cent of the commercial crop in the years 1918-1920 was grown in the irrigated valleys of the far western states by men who grow little else than apples; and probably fifty per cent more was grown in commercial orchards in small areas in Missouri, western Michigan, western New York, Virginia, and adjacent states, as shown in Figure 6. This geographic specialization in apple production, with coincident decline of the so-called farm orchards, is a development largely of the past thirty years.

The same concentration of production is occurring in practically all the fruit crops and the vegetables, also in the production of butter and cheese, of sugar, tobacco, beans, and, to a less extent, of potatoes. It appears almost inevitable, if there be further development and cheapening of transport facilities, that this trend toward the specialized production of these less important crops and products in certain localities, where climate and soil and accumulated community skill and experience provide peculiarly favorable conditions, will continue; and it is not inconceivable that this development in the United States may result eventually in that geographical differentiation of agricultural production so characteristic of portions of western Europe.

But, on the other hand, if transportation should become more expensive, as seems not unlikely despite the progress of invention, owing to the great increase in cost of coal and labor, the effect would be to encourage local specialization in production, particularly of vegetables and fruits, near the large cities and discourage the development of highly specialized districts of production remote from the markets. In other words, the trend during the past century toward the development of specialized agricultural industries wherever geographic conditions were most favorable, more or less without regard to State or even national boundaries, would be reversed, and each locality would tend to become self-supporting. Geographic differentiation in agricultural production

would still exist, but it would be more local than national or international in character,—more like the agriculture of China.

Illustration from Wisconsin.—The dairy industry in Wisconsin affords a particularly fine illustration of the way in which economic forces compel closer adjustment of types of farming to geographic conditions. Wisconsin now has more dairy cows and probably produces more milk than any other state in the Union. In April 1920 there were 2752 cheese factories in the state, 762 butter factories, 67 condensed and evaporated milk plants, and the total value of dairy products was estimated at 277 million dollars. The development of the dairy industry in this state has been due largely to temperature conditions. First, the cool summer temperatures favor a low bacterial content in the milk and the production of a quality of dairy products, especially cheese, which is not readily obtainable in warmer climates. Secondly, the low temperature and high summer rainfall promote pasturage of high quality which is best utilized by dairy cows, and which also reduces the agricultural work of the summer so far as the feeding of cattle is concerned. Thirdly, for the same reasons, corn can be grown for silage, but not so satisfactorily for grain, and the silage, together with hay, the production of which is favored by the climate, provides excellent winter feed for dairy cattle. Fourthly, dairying affords profitable employment to the rural population during the winter, and thus is peculiarly adapted to the climatic conditions existing in the state.

Within the state, moreover, there has occurred a gegraphic division of territory between the production of butter and of cheese which also has been due largly to the influence of temperature conditions. In 1875, when the dairy industry in Wisconsin was in its infancy, cheese factories and creameries were intermingled in the southeastern portion of the state, to which section they were largely confined at that time. But immediately economic forces began to compel adjustment to geographic conditions, causing the abandonment of cheese production in the warmer southeastern section of the state and the development of the industry on the highlands to the west and along the Lake Michigan shore counties to the northeast. By 1910 all the cheese factories in Kenosha, Racine and Walworth counties had gone out of business, and also all those in the lower eastern portion of Rock county, leaving the creameries to possess the southeastern section of the state (except for city milk production). On the other hand, in the highlands to the west, the thirty-seven cheese factories of 1875 had increased in number to 577 by 1910, while only eight creameries remained in Green, three in Lafayette, and six in Iowa county in this highland district, and most of these were located in the warmer, lower, and

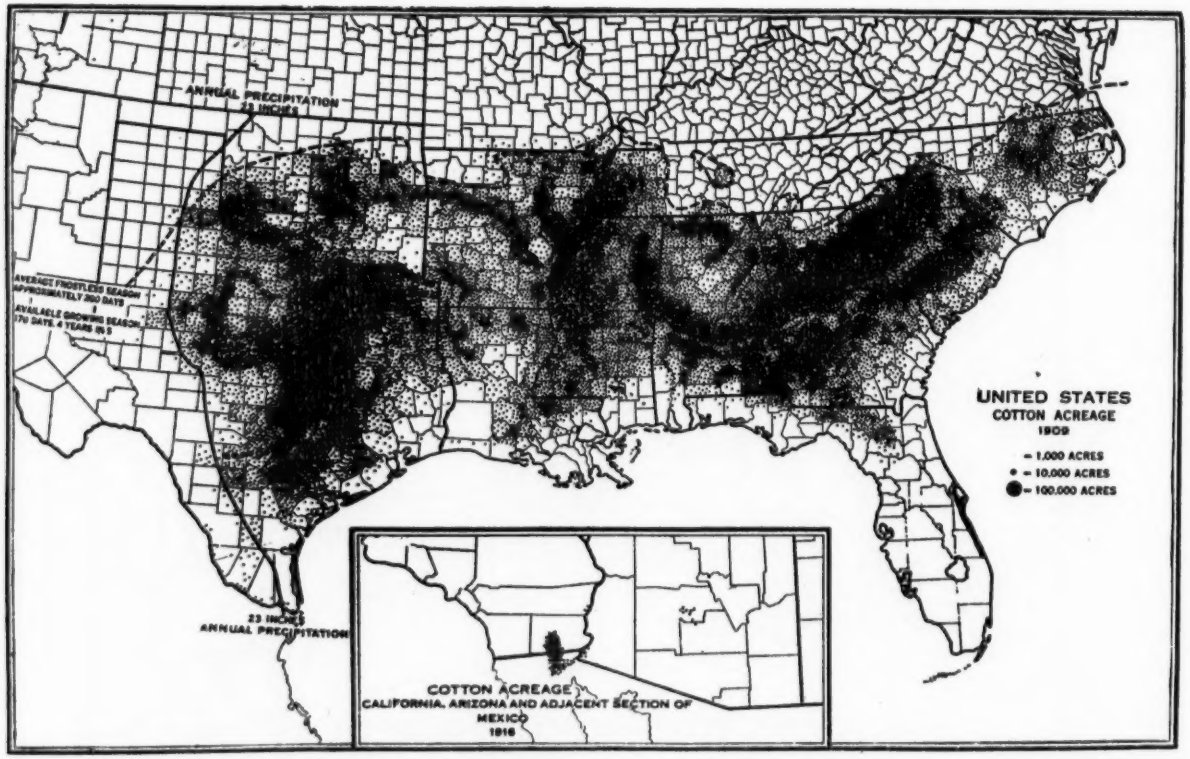

FIG. 5.—The northern limit of commercial cotton production follows closely the average summer temperature line of 77°, and very little cotton is grown where the average season between killing frosts is less than 200 days. The western limit is approximately the line of 23 inches average annual precipitation.

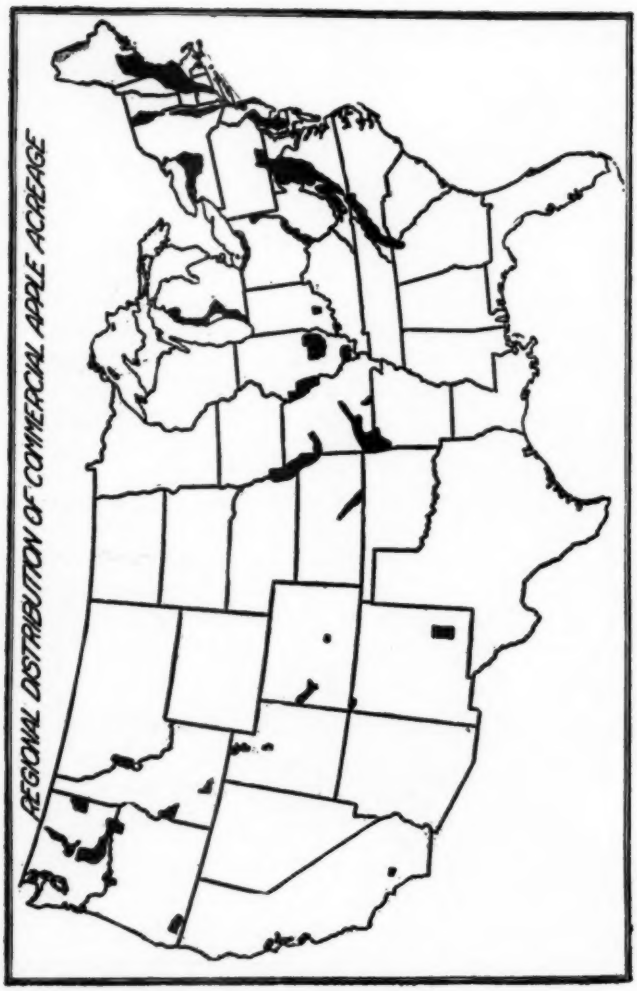

FIG. 6.—It is estimated that over 80 per cent of the commercial apple crop of the United States is produced in the limited areas indicated by the shading.

more sandy river valleys. A similar development of the cheese industry and decline of the butter industry occurred in the cooler Lake Michigan shore counties.[11]

The influence of the temperature factors upon the use of land is, perhaps, more commonly exerted indirectly than directly. Flax, for instance, in the self-sufficing, domestic, agricultural economy of the colonial era, was grown on most farms within its climatic range in order to provide linen for the household; but now its culture is practically confined to the northern Great Plains region, not alone because it finds there a favorable environment, but primarily because it has been excluded from other favorable areas by the competition of crops having more limited climatic requirements, or which for other reasons command a higher price.

This is an important modifying principle to be kept in mind in considering the use of land,—that the crop or farm enterprise most limited by climate, or otherwise, will, ordinarily, have the first choice of land, and will tend to push the less profitable crops beyond the periphery of its climatic limit, or at least keep them off the land necessary to produce a sufficient quantity to meet the effective demand. Thus, cotton excludes corn to a greater or less degree from the best lands of the Cotton Belt, not because corn does not thrive on such lands, but because corn can be grown elsewhere and cotton cannot be with equal success. Likewise corn practically excludes sugar beets from the northern part of the Corn Belt, not because sugar beets do not do well, but because they have a lower temperature requirement and can be grown equally well in other regions where corn does not mature.

The Rising and Falling Margin, or Standard of Utilization, of Land for Crops.—In concluding this discussion of the increasing importance of the physical factors in relation to the use of the land it seems fitting to inquire whether the margin of utilization of land for crops is rising or falling.

First, with reference to topography, the margin has unquestionably been rising and probably it will continue to rise until, and doubtless after, the real wages of agricultural labor have begun to decline. Throughout the United States the rough hill lands that were cleared for crops when population was less mobile and agriculture less commercialized are reverting to pasture or to forest. The declining birth rate, the prospect of a vast increase in importation of sugar and vegetable oils from the tropics, and the rising prices of forest products indicate that possibly for twenty years more rough fields in the hills of New England, the Appalachians, and the Sierra, will be permitted slowly to return to forest or be purchased by the state for such purpose.

[11] For a fuller discussion see Bulletin No. 223. 'The Climate of Wisconsin and Its Relation to Agriculture." A. R. Whitson and O. E. Baker.

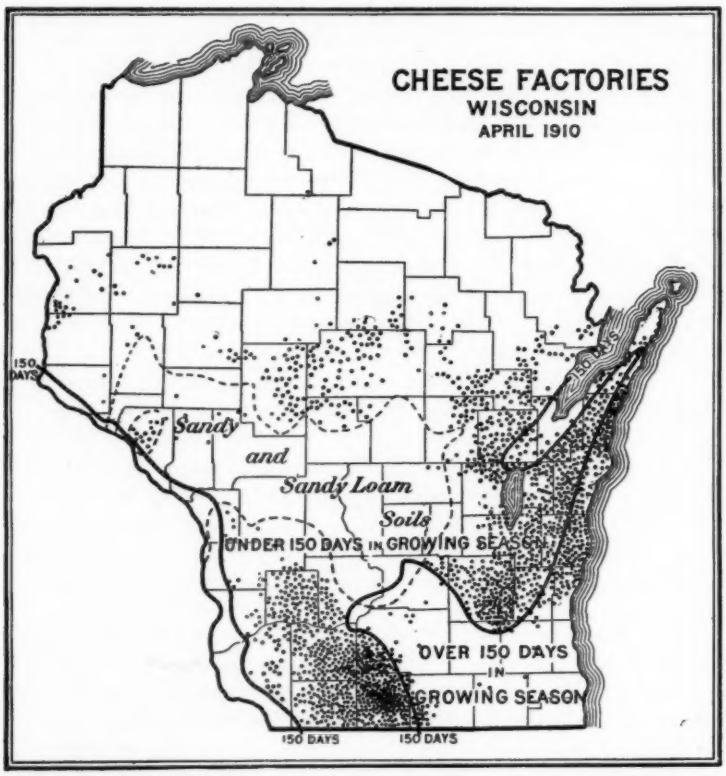

FIG. 7.—Relation of Cheese Districts to Length of Growing Season. Cheese production has developed in those portions of Wisconsin having less than 150 days in the growing season, except in the area of sandy soils. The short, cool season favors summer pasture and cheese production rather than corn and winter butter production, but sandy soils are unfavorable to good pastures. Map from Bulletin No. 223, Wisconsin Agricultural Experiment Station, 1912.

With reference to soils, whether the margin of utilization for crops rises or falls will depend largely on the price of farm products and the cost of ameliorating the adverse physical conditions, particularly the cost of fertilizers. Soil conditions are more susceptible to amelioration, as already pointed out, than the other physical factors, and for this reason the margin of utilization is very responsive to economic forces. In some localities, as in the sandy soils of the Lake states and the stony soils of New England, the margin of utilization is rising; in other localities, as along the South Atlantic Coast, owing largely to the use of fertilizer on crops enjoying a sort of climatic monopoly, and to the excellent transportation facilities by both rail

and water, the margin of utilization is falling. On the whole, the nation is probably at the turning point in the matter of utilization of deficient soils. Agricultural products will come in increasing proportion from the better soils, but the demand will probably be so great as to require the utilization for crops, by means of fertilizers and otherwise, of progressively poorer and poorer soils.

With reference to moisture, undoubtedly crops are being grown in the United States to-day under drier conditions than ever before, owing to economies in labor cost effected by using large scale machinery, to better knowledge of dry-farming processes, and to the introduction of drought resistant crops. With closer adaptation of the system of farming to climatic conditions, a considerable increase in crop acreage is likely to occur in the semi-arid regions. The margin of utilization, in other words, is falling.

Finally, with reference to temperature conditions, considerable readjustment is likely to continue in the inter-relations of crops and of systems of farming; but inasmuch as only in a very small area in the United States are temperature conditions so severe as to preclude the production of such crops as hay, barley, and potatoes, the margin of utilization of land for crops, as contrasted with its utilization for pasture or forest, is little affected by temperature conditions. The margin of utilization for some crops, particularly those whose production can be easily overdone,—cotton, the fruits, vegetables, potatoes, etc.,—is rising, that is, their production is concentrating into areas possessing the most favorable conditions; but other crops, particularly hay, corn, and the large seeded legumes, occupy the land thus released.

Summary.—The margin of utilization of land for crops, therefore, with reference to topography is rising; with reference to soils is probably stationary on the whole, but likely to fall rapidly, unless importation of tropical food products becomes very important; with reference to rainfall is falling; with reference to temperature is practically unaffected. Consequently in certain regions the margin is rising, in other regions, falling; but for the United States as a whole it is apparently falling; that is, agricultural settlement is advancing onto poorer and poorer land. One who has seen the struggles and failures of the young, ambitious, and often capable farmers in the drier portions of the Great Plains, in the sandier sections of the Lake States, or on the leached lands of the South, becomes convinced that the good land is occupied and that land both cheap and fertile no longer exists in the United States. The phenomenal rise in rents and in values of the best lands points to the same conclusion. The waves of population are beating against the barriers of adverse physical conditions all along the shore-line of settlement.

The United States is passing through, if, indeed, it has not already passed, the most significant period in its history. Heretofore the general standard of well-being has been largely maintained, if not improved, by the advance of agriculture onto the fertile lands that occupy the central portion of the continent. Hereafter it can be maintained, only with difficulty, by utilizing the agricultural land, now practically all in farms, more intensively, and with greater attention to the geographic conditions. As the pressure of population upon the agricultural resources of the nation rises, as land becomes scarcer and more valuable, greater and greater care must be exercised in using each kind of land for the purpose most favored by the physical conditions.

With the exhaustion of the virgin stands of timber, the production of lumber and forest products will be placed on an economic basis, and the growing of wood as a crop will enter into competition with other crops, especially for the use of the poorer lands. It is estimated that the present area of forest and woodland, if managed in accordance with forestry principles, could supply, in course of time, the lumber and forest products needs of a population considerably greater than that at present.[12]

With the increase of population meat will increasingly become a luxury and command a price which will compel the use for pasture of much land not suited to crops which is now lying unused or only partly used. Pasture will compete with forest for the use of the less hilly land, and even with crops in the more humid regions; and pasture land, by the use of fertilizers and other means, will be made to carry probably twice its present quota of livestock.

The productivity of crop land cannot be increased to the same extent as forest and pasture lands, but probably the average yields per acre could be increased fifty per cent over those at present, if prices of farm products rose accordingly. The productivity of crop land is, in general, so much greater than that of forest or pasture land that crops will have first choice of the land. Among the crops there are also great differences in productivity, and the more productive crops, such as the vegetables, cotton, corn, alfalfa, will, undoubtedly, to greater extent even than at present, be grown on the better lands. In brief, as population increases, as the prices of agricultural products advance, as agriculture becomes more intensive and commercialized, the use of the land must be fitted to the geographic conditions with greater care and precision.

[12] "Timber Depletion, Lumber Prices, Lumber Exports, and Concentration of Timber Ownership." U. S. Forest Service, Report on Senate Resolution 311, June 1, 1920, p. 39.

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GEOGRAPHIC FACTORS IN THE ANCIENT MEDITERRANEAN GRAIN TRADE

ELLEN CHURCHILL SEMPLE

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EARLY IMPORTANCE OF THE MEDITERRANEAN GRAIN TRADE.—The grain trade of the Mediterranean region assumed peculiar importance from very early times. This was due to several causes. Population tended to concentrate on or near the coasts, where maritime conditions encouraged trade and fisheries. There population outgrew the local means of subsistence; for except in a few favored districts, the supply of breadstuffs was inadequate or was subject to fluctuations which made imports necessary. The predominant mountainous relief, thin soils of weathered limestone, the paucity of alluvial valley lands and coastal plains, the practical restriction of grain crops to the winter or rainy season, the elimination of summer crops to compensate for scant harvests from the autumn sowing, the unreliability of the fall and spring rains on which the success of the crops depended, especially in the Eastern Basin,—all combined to make the geographical distribution of grainlands a matter of immense importance in early Mediterranean history.

This was especially true of wheat. According to the ancient writers, wheat required rich, humid earth, preferably deep valley alluvium with plenty of ground water, or fertile volcanic soils retentive of moisture, like that about Naples and Syracuse.[1] Wheat was also fastidious as to its rain supply in the period of germination; this made the exact date for fall sowing a constant problem for the ancient Mediterranean farmer, who saw his hopes of harvest blasted if the

[1] Vergil, Georgic II, 217-224. Columella, II, 9. Theophrastus *Historia Plantarum*, Bk. VIII, ch. IX, 1, 2.

autumn showers held off a few days after he had "consigned his seed to the unwilling earth," as Virgil expresses it. The same thing is true today; the result of the harvest still depends upon the timely advent of the fall and spring rains.[2]

Barley, which was probably indigenous to this region, was far less exacting both as to soil and weather, and therefore better adapted to Mediterranean conditions. Hence it was widely cultivated, from sea level up to 1500 meters (4900 feet). As barley cake and barley broth, it constituted a food staple for the common people, except where the local wheat was ample or the foreign sources of grain accessible to an active merchant marine; for the cost of land carriage was generally prohibitive for this bulky commodity. The price of barley was only one-half or two-thirds that of wheat.[3] This fact reflects the wide distribution of soils and climate suited to barley production, the limited total area of the wheat lands, their uneven distribution which involved heavy marine freight charges to get the product to the best markets, and finally the relatively greater demand for the choicer grains with the advance of civilization. Barley was the earlier and probably the aboriginal cereal in the Mediterranean lands. Wheat is mentioned only three times in the Iliad and six times in the Odyssey a century or more later; but barley in many varieties is frequently mentioned in Homer.[4] The early worship of Demeter at Eleusis in the only fertile alluvial plain of Attica and at Pyrasus in the old lacustrine basin of Thessaly point to the introduction of wheat culture in those districts.[5] The sacrificial bread in religious ceremonies of Greece and Rome was always barley cake, evidence of the primitive use of barley as opposed to wheat. In the time of Cato, however, the cereals cultivated in Italy were chiefly spelt (*far* or *ador*) and wheat, with some barley and millet.[6]

Oats and rye were unsuited to Mediterranean tillage owing to insufficient moisture, though fodder crops of rye were raised in a few northern localities with ampler rainfall and abundant ground water. Millet and panic, which required both heat and moisture, found ideal conditions in the irrigated fields of the Nile valley and the Cilician lowland,[7] where they were grown extensively. In other parts of the Mediterranean basin they were spring crops; were planted at the vernal equinox, throve with but little irrigation, and matured after a short

[2] A. Philippson, *Das Mittelmeergebiet*, p. 167. Leipzig, 1907.

[3] Polybius, Histories, Bk. II, 15; Bk. XXXIV, 7, 8. Boeckh, Public Economy of the Athenians, pp. 128-131. Trans. from the German. London, 1857.

[4] T. D. Seymour, Life in the Homeric Age, p. 328. New York, 1907.

[5] Iliad, II, 695. Hymn to Demeter in the Homeric Hymns.

[6] Mommsen, History of Rome, vol. III, p. 66. New York, 1905.

[7] Xenophon, Anabasis, Bk. I, ch. II, 23.

growing period.[8] Millet and panic kept well and were used for bread or porridge, to a limited degree in ancient Greece,[9] but more extensively in Cisalpine Gaul, because the water supply and occasional summer showers of the Po valley insured abundant millet crops.[10]

Owing to conditions of climate and relief, and to the geological composition of the soils, wheat lands were sparsely distributed and, with a few exceptions, limited in area. Narrow alluvial valleys or lacustrine plains yielded enough wheat for the local demand where the population was small, as in ancient Boeotia, or was satisfied with a predominant barley diet, as in the retarded parts of Greece and Italy. Regions of large wheat production were widely separated, while population tended to pronounced concentration around the big industrial and commercial cities of the Mediterranean littoral, whose advanced culture was associated with fastidious palates demanding wheat as opposed to the widespread plebeian barley. The grain trade was therefore mainly wheat trade. Rarely were generous wheat lands and dense populations contiguous; but markets for the one and breadstuffs for the other were provided by the navigation early developed in this enclosed sea by a fortunate combination of geographic conditions. The districts of big wheat production were Egypt and the Pontic coastlands, which lay outside the Mediterranean climatic region, the Hauran, lowland Cilicia, Thrace, Sicily, parts of Italy, Spain, Numidia and Carthaginian Africa. These raised a sufficient surplus to maintain an export trade, which fluctuated with crop conditions in other parts of the Mediterranean Basin.

Conditions of Navigation Affecting the Grain Trade.—Local production of wheat, however, was everywhere common. It utilized small fertile fields or even mediocre soils, where the seed had to be thinly planted and the harvest was correspondingly meagre. This was due to the fact that the chief importing centers got their foreign wheat from overseas, and that the period of navigation, when such imports could be made, was limited to the four and a half months between early May and the fall equinox. Even this short term was sometimes curtailed by the early advent of autumnal storms. Moreover communication along the sea-lanes was liable to interruption in time of war, as when the Spartan fleet during the Peloponnesian war seized the Boeotian grain ships, laden with Thessalian wheat, as they emerged from the port of Pagasae;[11] or when Sparta in the Peloponnesian

[8] Theophrastus, *De Causis Plantarum*, Bk. IV, ch. VII, 2. *Historia Plantarum*, Bk. VIII, ch. I, 1-4; ch. VII, 3; ch. XI, 1.

[9] Naumann and Partsch, *Physikalische Geographie Griechenlands*, p. 446, Breslau, 1885.

[10] Strabo, Bk. V, ch. I, 12.

[11] Xenophon, Hellenes, Bk. V, ch. IV, 56.

war and Philip in the Macedonian wars intercepted the foreign wheat cargoes bound from various points to Athens; or when Agathocles of Syracuse in 310 B. C. understood to break up the importation of wheat into the rival state of Carthage from Sicily and Sardinia.[12]

Piracy also was a recurrent threat to the wheat trade. This threat was particularly ominous to small islands like Rhodes and Aegina, which constantly took a hand in the suppression of piracy, not only to save their commerce but to supply the home grain markets. Even Rome suffered. For years before Pompey's dictatorship of the Mediterranean in 67 B. C., the depredations of the pirates on the Roman grain ships caused serious scarcity of provisions in the capital and other parts of Italy which relied upon foreign wheat. Circumstances of weather or war, therefore, which cut off the oversea supply of wheat, encouraged the production of home-grown grains to serve in an emergency. Moreover the cost of sea transportation left the local grain a margin of profit, which probably covered the cost of labor and fertilizer necessary to maintain the productivity of the home fields; for the transport vessels were small, the crews were large owing to the need of oarsmen to propel the ship when the course lay in the teeth of the Etesian winds, the voyages were long and slow, and the interest on borrowed capital for such ventures was high, in Athens often 30 per cent.

Grain Trade of the Levantine Sea.—In the Eastern Basin of the Mediterranean, about the Levantine Sea, the grain trade originated at a very early date, owing to the scant and uncertain rainfall. The Nile valley raised irrigated crops of wheat and barley, and, by 1500 B. C., probably durra or black millet[13] far beyond the needs of the local population. Therefore Egyptian wheat figured in the caravan trade with Palestine from patriarchal times during the not infrequent years when drought brought famine or scarcity to Judea and Israel. Palestine raised barley on its infertile limestone highlands; but it seems to have drawn its wheat chiefly from the abundant supplies of the Hauran, the ancient Bashan. This is a high plateau (600-700 meters elevation) east of the upper Jordan and the Lake of Galilee. The west winds from the Mediterranean bring it an average of 400 mm. of rain in winter and early spring, just enough for wheat, supplemented by the considerable dews. In antiquity, judging from numerous ruins of aqueducts and reservoirs, the inhabitants conserved the water draining from the lofty Mount Hauran (1800 meters) on the east, and in dry years distributed it by irrigation canals over the

[12] Diodorus Siculus, Bk. XXI, fragment 12.

[13] A Erman, Life in Ancient Egypt, p. 434. London, 1894.

tilled land, as the people do to-day.[14] The Hauran is an old volcanic district; its soil consists of disintegrated lava, rich in plant food and retentive of moisture, overlying the limestone which elsewhere in Palestine forms the surface rock.[15] The Hauran was therefore the granary of Syria, probably the source of the wheat which in ancient times was exported from Palestine to Tyre[16] and even to Greece.[17]

The terraced slopes of Phoenicia were better adapted to gardens, vineyards and orchards than to field agriculture. Hence the populous commercial cities of the Lebanon coast drew upon the wheat of the Nile valley in their extensive exchanges with Egypt, and probably also from the wide and well watered alluvial plain of lowland Cilicia, where they seem to have maintained colonies at an early date, till dislodged by the expanding Greeks. Cilicia was famous for its grain fields in the time of Xenophon,[18] and to-day it raises cereals as winter crops on its 1200 square miles of tilled land.[19] Near-by Cyprus, which in antiquity had a reputation for fertility, produced enough wheat on the alluvial floor of its broad intermont valley to supply the local demand in the time of Strabo,[20] and occasionally for export, for Athens bought Cyprian grain.

Grain Trade of the Aegean Coastlands of Asia Minor.—The western front of Asia Minor, which took so active a part in ancient Hellenic life, had grain enough and to spare. The old Aegean folded mountains of Mysia and Hellespontine Phrygia, and the crystalline mass of Lydia and northern Caria are all overlaid with late Tertiary deposits and volcanic outflows, which have contributed important elements of fertility to the silted floors of the subsidence valleys penetrating inland from the embayed coast.[21] The alluvial plains of the Scamander, Caicus, Hermus, Cayster and Meander rivers all had a reputation for fertility in ancient times[22] which made them constant objects of conquest.[23] They yielded wheat crops which were further aided by a favorable climate.[24] The Aegean winds distribute moderate

[14] Ewald Banse, *Die Turkei*, pp. 353, 357, 358. Braunschweig, 1917.

[15] D. G. Hogarth, The Nearer East, pp. 66, 136, 188. London, 1902. E. Huntington, Palestine in Its Transformation, pp. 31, 230-235. Boston, 1911.

[16] I Kings, V, 11. Ezekiel, XXVII, 17.

[17] Theophrastus, *Historia Plantarum*, Bk. VIII, ch. IV, 3. Varro, *Rerum Rusticarum*, I, 44.

[18] Xenophon, Anabasis, II, 23.

[19] E. Banse, *Die Turkei*, p. 176. 1917.

[20] Strabo, XIV, ch. VI, 5.

[21] E. Banse, *Die Turkei*, pp. 124-140. 1917.

[22] Herodotus, I, 149.

[23] Strabo, Bk. VIII, ch. IV, 6; Bk. XII, ch. IV, 4; Bk. XIII, ch. IV, 2, 5, 13.

[24] Vergil, Georgic I, 103. Herodotus I, 142.

rains (500 to 650 mm.) for 60 miles inland.[25] Caria south of the Meander valley floor is a mountainous land of bare crystalline rock, poor thin soil, and a pronounced Mediterranean climate with six months of summer drought. The inhabitants of this coast were forced to seek foreign foodstuffs and to follow commercial vocations;[26] hence the maritime trade of Cnidos and Halicarnassos. The mountain land of Lycia is dissected by gorges, which open on the coast into deltaic flats at the head of protected bays. These small alluvial areas and certain limited lacustrine basins of late Tertiary deposits far up in the mountains furnished the rich "wheat-bearing tilth" of Lycia which Homer praised.[27] It was a self-sufficing land, condemned to isolation, which was reflected in the characteristically detached life and peculiar culture of the people.

The populous Hellenic cities, distributed along the Aegean coast and off-shore islands of Asia Minor, absorbed the surplus grain of the inland states, when they could get it, and reached out overseas for more. They occupied narrow coastal strips, small islands and peninsulas with limited area and mountainous relief. Only Naxos, Samos and Lesbos had a little level land which gave them a reputation for fertility.[28] The island cities at times, by a recognized law of anthropogeography,[29] acquired territory on the opposite coast to extend their land base, as did Samos, Rhodes, Chios and Mytilene.[30] Chios secured a foothold on the Mysian littoral by a shady transaction which gave it Atarneus,[31] market for the grain of the fertile Caicus valley. Mytilene levied on this same Caicus wheatland during the Persian War.[32]

The Hellenic cities, however, were often excluded from the neighboring grain markets by wars waged by the alien inland powers of Asia Minor for the conquest of the Aegean littoral. Hence in their food quest, which was always combined with various commercial enterprises, they turned their ships to the wheat fields of Egypt, the Pontic coastlands of Scythia (Russia), the broad Quaternary plain of eastern Thrace, and the volcanic soils of Sicily. On the coasts of these corn countries they planted colonies as export points for the productive hinterland. A significant connection existed between soil and this

[25] E. Banse, *Die Turkei*, pp. 124-125. 1907.

[26] Ibid., pp. 125, 142.

[27] Iliad, XII, 314-315; XVI, 672-673, 682.

[28] Herodotus, V, 31. Strabo, Bk. XIV, ch. I, 14, 15.

[29] E. C. Semple, Influences of Geographic Environment, pp. 252-253, 444-445. New York, 1911.

[30] Herodotus, III, 39; I, 160. Strabo, XIV, ch. I, 33; ch. II, 2. Thucydides, III, 50; IV, 52.

[31] Herodotus, I, 160; VIII, 106.

[32] Herodotus, VI, 28.

class of settlements. In some cases the Greek colonists helped cultivate the land; in others, they bought the produce of the native population. They also established settlements at strategic points along the sea routes to the grainlands to maintain the line of communication. These way-stations developed a middleman grain trade, owing to the great length of the sea routes and the short duration of the sailing season.

Looking at the evidence, we find that eleven Hellenic cities of the Asia Minor littoral and offshore islands participated in the trading colony of Naucratis on the Canobic arm of the Nile. These cities were Mytilene, Phocaea, Chios, Clazomenae, Teos, Samos, Miletus, Halicarnassos, Cnidos, Rhodes and Pharselis, besides the Greek island city of Aegina.[33] The Aeolian settlements of this coast, whose land enjoyed an exceptional reputation for fertility,[34] had only one representative in the Egyptian enterprise, namely Mytilene, which shared the island of Lesbos with five other city-states. Mytilene was also interested in the Pontic fields, whence it imported wheat.[35] It occupied and fortified Sigeum at the entrance to the Hellespont as early as 600 B. C.,[36] and later built Aenos near the mouth of the Hebrus River[37] (Maritza), which was the Aegean port for the Thracian wheatlands.

The Ionian Miletus, a populous industrial city, took the lead in colonizing the remote Pontic wheatlands by founding Olbia near the confluence of the Bug and Dnieper rivers, and Panticapaeum on the Crimean Bosporus.[38] On the opposite shore of the Strait, Ionian Teos founded Phanagoria. To secure her lines of communication with the Pontic markets, Miletus planted colonies along the Hellespont and Propontis, either alone or assisted by other Ionian towns like Clazomenae, Phocaea and Erythrae.[39] Clazomenae regularly imported its wheat,[40] and doubtless the others did also. On the Thracian shore of the Propontis, Samos founded a colony at Perinthos, which became an export point for Thracian grain. The islands of Rhodes, Chios and Cos were especially active in the Pontic trade, and therefore participated in all Hellenic movements, military or political, to maintain a free passage for merchant ships through the Bosporus and Hellespont.[41] Rhodes turned also to the grain fields of distant Sicily, and

[33] Herodotus, II, 178.
[34] Herodotus, I, 149.
[35] Thucydides, III, 2.
[36] Herodotus, V, 94.
[37] Strabo, Fragment 52.
[38] Strabo, Bk. VII, ch. III, 17; ch. IV, 4.
[39] J. B. Bury, History of Greece, p. 92. London, 1909.
[40] Aristotle, Economics, Bk. II, ch. XVII.
[41] Polybius, IV, 46, 47, 52. Bury, History of Greece, pp. 722-723. 1909.

founded there the colony of Gela on the margin of a fertile plain,[42] about 688 B. C. After the Roman conquest of Sicily, Rhodes secured a permit to export annually 150,000 bushels of Sicilian wheat.[43] It is a significant fact, too, that the Ionian cities of Asia Minor, when threatened with destruction by the Persians, discussed a recurring project to abandon their homes and settle in Sardinia.[44] They were undoubtedly attracted by the security of an island location; but their anticipations of a prosperous future in Sardinia were probably based upon mariners' accounts of the rich valley soil and excellent wheat land of the island.

The Limited Grain Lands of Greece.—Greece was scantily supplied with wheat land, owing to its small area, rugged relief, narrow alluvial valleys, and prevailing infertile soils produced by the weathering of Cretaceous limestones and crystalline rocks. The later Tertiary deposits, whose easily weathered marls made good tillage land, were limited in extent, but they contributed much to the fertility of the valleys of Laconia, Messenia and Elis.[45] The rivers of Greece, being mostly torrents, deposited in their deltaic plains chiefly coarse detritus unfit for tillage. Only a few longer streams, with a well-developed lowland course, afforded the alluvial flats of rich deep soil suitable for wheat fields; yet even these strike the modern traveller as pitiably small. The river plain of Argos, praised by Homer, comprises about 30,000 acres, yet it offered the only local wheat land for three cities,—Argos, Mycenae and Tiryns, besides the seaport of Nauplia. On the other hand, barley, which yielded a fair crop even from poor soil, was widely cultivated, and formed the main diet of the people. Barley bread and barley stew, supplemented by cheese, fruit and wine, constituted the public meals at Sparta in the time of Lycurgus.[46] Wheat bread was a delicacy served as dessert. In early Attica it was eaten only on feast days, till the development of maritime trade made it a commonplace.[47]

Laconia, "lying low among the rifted hills" as Homer described it, was a rugged country suited chiefly for barley culture. Its wheat, which was light in weight and poor in food value,[48] was probably grown only in the narrow valley plain of the Eurotas River. Messenia,

[42] Herodotus, VII, 153. A. E. Zimmern, The Greek Commonwealth, p. 66, 1911.
[43] Polybius, XXVIII, 2.
[44] Herodotus, I, 170; V, 124.
[45] Naumann and Partsch, *Physikalische Geographie Griechenlands*, pp. 347-348. Breslau, 1885.
[46] Plutarch, Lycurgus, VIII.
[47] W. Richter, *Handel und Verkehr der wichtigsten Völker des Mittelmeers im Altertum*, p. 94. Leipzig, 1886.
[48] Theophrastus, *Historia Plantarum*, Bk. VIII, ch. IV, 5.

which comprised the broad and fertile Macaria plain at the head of the Messenian Gulf, was accessible to the rain-bearing winds from the west and was watered by numerous streams. Its soil, described by a Spartan poet as "good to plant and good to ear," enjoyed a rare reputation for productivity from very early times.[49] This aroused the cupidity of over-crowded Sparta, which in the seventh century B. C. annexed Messenia after a series of wars, and thereby supplied three thousand young Spartans with new land allotments.[50] Yet wheat remained scarce, and even the local barley crops yielded no margin for times of stress. During the Peloponnesian War, Sparta relied on wheat from Sicily; Athens, to check this trade, sent a fleet in 427 B. C. against Syracuse, the chief export point.[51] During the war of Agesilaus of Sparta against Persia, a flotilla of wheat transports bound from Egypt to Laconia was intercepted in 395 B. C. by the Athenian fleet, then an ally of Persia.[52]

Elis doubtless supplied the local demand for grains from its fertile and fairly ample coastal plain, which was overlaid by late Tertiary marls,[53] enriched by the alluvial deposits of the Peneus and Alpheus Rivers, and adequately watered by the western rains; for the Elians seem to have taken no part in the grain trade. Achaia, on the other hand, which occupied the steep northern escarpment of the Arcadian highland and had only small fragmentary alluvial flats along the Corinthian Gulf, was early driven to colonize Zakynthos, famous for its fertility,[54] and also the small but rich alluvial plains of Sybaris and Metapontum in Southern Italy, where essentially agricultural states developed.[55] The deltaic lowland of the Cratis River at Sybaris gave the largest yield of wheat *per jugerum* in all Italy,[56] and with the Metapontum fields was perhaps the first part of Italy to raise grain for export.[57] Corinth,[58] Megara[59] and Aegina, owing to small area, poor soil and rugged relief, despite careful methods of tillage, were forced to import grain, though little Aegina raised good crops of barley.[60] Therefore Corinth, expanding early, occupied points in southern Acarnania along the Achelous River, whose alluvial plain,

[49] Odyssey, III, 495. Tyrtaeus in Strabo, Bk. VI, ch. III, 3. Euripides in Strabo, Bk. VIII, ch. V, 6. Bury, History of Greece, p. 127. 1909.

[50] Ernst Curtius, History of Greece, vol. I, pp. 227-230. New York, 1872.

[51] Thuycidides, III, 86.

[52] Bury, History of Greece, p. 539. 1909.

[53] Naumann and Partsch, *Physikalische Geographie Griechenlands*, p. 348. 1885.

[54] Pliny, *Historia Naturalis*, IV, 54.

[55] Bury, History of Greece, pp. 103, 105. 1909.

[56] Varro, *Rerum Rusticarum*, Bk. I, 44.

[57] Mommsen, History of Rome, vol. I, p. 171. New York, 1905.

[58] Strabo, Bk. VIII, ch. VI, 23.

[59] A Philippson, *Der Peloponnes*, pp. 16-18. Berlin, 1892. Strabo, Bk. IX, ch. I, 6.

[60] Herodotus, VII, 147. Strabo, Bk. VIII, ch. VI, 16.

abounding in grain and timber, supplied the most urgent needs of this populous commercial city.[61] Corinth also colonized Potidaea on the Pallene peninsula of southern Macedonia, accessible to a region which produced grain, fruit and timber.[62] Megara secured a colonial foothold near the Sicilian grain fields at Megara Hyblaea, and near those of Thrace by founding Selymbria on the Propontis. She anticipated Miletus in seeking the Pontic wheat markets, for as early as 660 B. C. she insured her access to the Euxine by colonizing Chalcedon and Byzantium, the two warders of the Bosporus. The grain ships which Xerxes in 480 B. C. saw sailing through the Hellespont "on their way to Aegina and the Peloponnesus" were probably destined in part for Megara and Corinth.[63] Aegina's imports from Egypt through the station at Naucratis doubtless included Nile valley wheat, as well as some of the small wares which she hawked about the eastern Mediterranean.

Hellas or Central Greece had a poor reputation among the ancients for fertility,[64] and northern Greece was little better. In Homeric times rugged Epirus, inhabited by the Thesprotians, drew supplies from "the grain fields of Dulichium," probably one of the deposit islands near the mouth of the Achelous River.[65] Wheat lands existed only in small detached districts, as in the Achelous lowland and the valley plain of the Sperchius River, which was considered fertile in Homeric times. The plain of Opuntian Locris and the Crissian plain of rugged Phocis were fertile, but minute. The latter, which would make a good-sized American farm, was dedicated to the shrine of Apollo at Delphi; but it was so rare a bit of tillage land that the neighboring hill-towns of Crissa and Amphissa could not resist the temptation of cultivating it for their own use, and thus brought on the Sacred Wars.[66]

Grain Production in Attica.—Attica had the poorest soil of all Greece. The land was so unproductive that it attracted no invaders, Thucydides tells us.[67] The little Eleusinian plain sacred to Demeter, who here introduced the cultivation of cereals,[68] a few districts in the valley of the Cephissus, and the small alluvial Marathon plain alone could claim fertility. These must have produced Attica's meager wheat crop. According to the Eleusinian inscription of 328 B. C. the average

[61] Strabo, Bk. X, ch. II, 3, 4. E. Curtius, History of Greece, vol. I, p. 290.
[62] Livy, XLV, ch. 30.
[63] Herodotus, VII, 147.
[64] Herodotus, III, 106.
[65] Odyssey, XIV, 335. Strabo, Bk. X, ch. II, 13-19.
[66] Bury, History of Greece, pp. 159, 724-725. 1909.
[67] Thucydides, I, 2, 5.
[68] Homeric Hymns, Hymn to Demeter.

yield of wheat was only one-tenth that of barley.[69] The wheat moreover was light and poor in food value.[70] The barley was excellent; it was the only cereal that could thrive on the porous red soil of weathered limestone and the residuum of weathered crystalline rock, which covered the surface of the Mesogaea or "Midlands" with mediocre soil.[71] A meager average rainfall of 408 millimeters (16 inches), which drops at times to 325 millimeters (13 inches), further reduced the productivity of this ungenerous land.

Athens like Sparta undertook at an early period to despoil some of her neighbors of their best grain land; but these territorial acquisitions were necessarily small. In 506 B. C. she took from Chalcis the fertile Lelantine plain on the neighboring coast of Euboea, and settled there 2000 Athenian colonists to secure her hold; about the same time she seized from Eretria the little deltaic plain of Oropus at the mouth of the Asopus River. This little garden spot had long been a bone of contention between Eretria and Boeotia, whose border it adjoined; and it came to be a chronic cause of enmity between Boeotia and Athens.[72] The small area of these acquisitions emphasize the urgency of Attica's need. The Lelantine wheat fields were vital to Athens as her nearest source of supply. Hence during the Peloponnesian War, the occupation of Decelea by the Spartans in 413 B. C. enabled the invaders to control the road across northern Attica, and thus crippled Athens by cutting its communication with Oropus and the Euboean granary.[73] The great Athenian expansionist Alcibiades[74] urged the expedition for the conquest of Sicily (415 B. C.), on the ground of the abundant wheat, barley and other food-stuffs of the island. Nicias, arguing against the expedition, said:—"The Sicilians have a numerous cavalry and grow their own wheat instead of importing it; in the last two respects they have a great advantage over us."[75] To the Athenian statesmen, the inadequate grain supply was a constant handicap. This weakness had to be counterbalanced by the development of extraordinary strength in other directions. Climate, soil, small area, a long indented coast line, and a commanding central location in the Eastern Basin of the Mediterranean, all combined to force Athens into a brilliant industrial and maritime development. This enabled the state in the age of Pericles to support a population of 250,000, one-half of them slaves, on its scant 700 or

[69] T. D. Seymour, Life in Homeric Greece, p. 328. New York, 1907.
[70] Theophrastus, *Historia Plantarum*, Bk. VIII, ch. IV, 5.
[71] Naumann and Partsch, *Physikalische Geographie Griechenlands*, p. 347.
[72] Bury, History of Greece, pp. 217-218. 1909.
[73] Thucydides, VII, 27, 28; VIII, 95, 96.
[74] Plutarch, Alcibiades, XVI.
[75] Thucydides, VI, 20.

750 square miles of area.[76] Boeckh's estimate of half a million population is excessive, because he grossly overestimates both the fertility and arable area of Attica.[77]

Only two states of Greece, Thessaly and Boeotia, raised an ample supply of wheat; Thessaly alone produced a margin for export.[78] Its extensive lake plains were famous for their fertility from Homeric times.[79] The large area and abundant resources of the land were the geographic foundation of Jason's ambition to make himself master of Greece and the neighboring countries.[80] Generous nature enabled the inhabitants to display a munificent hospitality and develop voracious appetites; "a Thessalian mouthful" was proverbial in Greece.[81] Boeotia was a small state, but it had productive wheat fields and gardens distributed in the lacustrine plains of Lake Copais and Lake Hylica and along the valley of the Cephisus. Fertile soil made the Boeotians a nation of farmers, unenterprising and stolid, but the best fed people of Hellas.[82] The Athenians regarded them with scorn, not unmixed with envy, because of their voracity; and indeed this characteristic made them the butt of the comic writers of Greece. One such humorist, when asked what sort of people the Boeotians were, replied that "they spoke just as vessels might be expected to speak if they had a voice, telling how much each of them could hold."[83]

The Boeotian wheat, according to Theophrastus, was the heaviest and best of the whole Mediterranean region, superior to the Libyan, Pontic, Thracian, Syrian, Egyptian and Sicilian, which in turn was the heaviest of all imported wheats. In proof of his contention, Theophrastus adduced the fact that the Boeotian athletes, who at home ate scarcely three pints of the native wheat a day, easily consumed five pints of Attic wheat when they were staying in Athens.[84] The Athenian wheat therefore seems to have ranked low in food value. The superiority of the Boeotian wheat persisted; when later it entered the grain market of Rome, probably as tribute, it yielded only to the very best Italian product, according to Pliny.[85] There is no evidence however, that the Boeotian grain was exported even across the border into Attica. It was doubtless absorbed by the home market.

[76] Bury, History of Greece, p. 378, note p. 870. 1909.
[77] Boeckh, Public Economy of the Athenians, pp. 50-57, 107-114. London, 1857.
[78] Xenophon, Hellenes, Bk. V, ch. IV, 5, 6; Bk. VI, ch. I, 11.
[79] Iliad, II, 695. Thucydides, I, 2, 3. Strabo, Bk. IX, ch. V, 2, 19.
[80] Xenophon, Hellenes, Bk. VI, ch. I, 8-18.
[81] Ibid., Bk. VI, ch. I, 3. Athenaeus, X, 12.
[82] E. Curtius, History of Greece, Vol. IV, pp. 349-352. New York.
[83] Erastosthenes, quoted in Athenaeus, X, 11.
[84] Theophrastus, *Historia Plantarum*, Bk. VIII, ch. IV, 5.
[85] Pliny, *Historia Naturalis*, XVIII, 7.

Early Development of the Greek Grain Trade.—Poverty of wheat land in Greece necessitated the importation of breadstuffs from the earliest times. Even the most fertile districts, owing to small area, had no surplus for emergencies. These emergencies, moreover, recurred, owing to the variable rainfall and frequent wars between the city-states, with the consequent devastations of the fields in the spring campaigns and interruption to tillage by military service. During the Peloponnesian War, Boeotian Thebes sent ships to Pagasae to buy Thessalian wheat, because for two years its land had remained uncultivated.[86] Preliminary to its revolt from Athens in 428 B. C. Lesbos made extensive importations of grain and other supplies from the Pontic coasts.[87] When the Persian invasion threatened Greece in 480 B. C., Gelon of Syracuse, foreseeing that the Pontic and Egyptian wheat ships bound for Greece would be intercepted by the enemy's fleets, offered to supply Sicilian grain for the entire Hellenic army, and to send a large naval and military force, on condition of his getting the supreme command of the allied forces.[88] This offer points to a long established wheat trade between Sicily and Greece. It also suggests a fact which impresses the investigator in this subject;—namely, that in the ancient Hellenic world wheat was the most important contraband of war.

Constant concern for their breadstuffs, especially wheat, harrassed all the Greek states of the mainland and islands except Boeotia, Thessaly and backward mountain communities like the Arcadian commonwealths, whom nature had long disciplined to an abstemious contentment with the local barley and acorns. This concern stimulated the maritime trade and colonial enterprises of all the distinctly commercial states, whose development was determined by the pull of ready access to the sea and the push of meager tillage land at home.[89] Their governments became the chief *entrepreneurs* in the grain business, because private capital, nervous over the big risks taken by the grain fleets, was limited, and therefore voracious as to profits; transportation facilities were restricted and unreliable; and food supply at any crisis became a national question.[90] Foreign grain markets had to be kept open by reciprocity treaties, and distant grain lands linked with Greece by seaboard colonies. These colonies duplicated the types which emanated from the Hellenic cities of the Asia Minor coast. They were agricultural, like Achean Sybaris and Metapontum on the delta

[86] Xenophon, Hellenes, Bk. V, ch. IV, 56.

[87] Thucydides, III, 2.

[88] Herodotus, VII, 158.

[89] E. C. Semple, Influences of Geographic Environment, pp. 15, 268. 1911.

[90] W. L. Westerman, Decline of Ancient Culture, Amer. Hist. Review, Vol. XX, p. 736. 1915.

lands of the South Italian littoral, and the AthenianThurii near the earlier Sybaris, where the people "could eat bread without measure;"[91] or strategic way-stations and middlemen ports, like the Athenian Sestos and Cardia on the Hellespont.

THE GRAIN TRADE OF ATHENS.—No other Greek state was so dependent upon foreign grain as Athens.[92] Even the Attic farmers relied on it in part, owing to the sterility of their fields.[93] The literature of Athens therefore yields fairly abundant historical material on the extent and control of the grain trade, and shows what probably happened also in other Greek states which carried similar geographical handicaps, but failed to leave behind so ample a record. Grain was brought to the Piraeus from the Pontic coast, especially the Crimea, from eastern Thrace, Syria, Egypt, Libya, Sicily,[94] and occasionally from the island of Cyprus. The Libyan wheat was doubtless the product of Cyrenaica, which had excellent grainland[95] and sufficient rainfall on the Barca plateau (1800 feet), for winter crops; but owing to the semi-arid climate and variable precipitation, the country probably raised a margin of wheat for export only in exceptional years. The same was doubtless true of Cyprus. This island, which normally raised only enough for local consumption, sent grain fleets to Athens in the time of Andocides[96] (468-400 B. C.), probably during the Peloponnesian War, when wheat commanded high prices.

Egyptian wheat was brought to the Piraeus not only by Athenian merchants, but also by foreign grain dealers from Rhodes, Miletus, Phoenicia and Egypt itself.[97] Rhodes and Miletus probably bought wheat beyond their own needs at Naucratis on the Nile, and sold the surplus to their sister state Athens. During a period of scarcity in 445 B. C., the king of Egypt sent a present of 40,000 medimni of wheat to be divided among the Athenian citizens.[98] The dependence of Athens upon Egyptian wheat was marked. After the Macedonian conquest of the Nile valley, Cleomenes, governor of Egypt, worked great hardship against Athens and other Greek states by controlling the export of Egyptian wheat, both as to price and destination. He imposed high export duties and sent the grain to the best market.[99]

[91] Bury, History of Greece, p. 380. 1909.

[92] Demosthenes' Orations, On the Crown, and Against Leptines. Xenophon, Hellenes, Bk. VI, ch. I, 11. Diodorus Siculus, I, 2.

[93] Livy, XLIII, 6.

[94] Theophrastus, *Historia Plantarum*, Bk. VIII, ch. IV, 5.

[95] Strabo, Bk. XVII, ch. III, 21. Pliny, *Historia Naturalis*, V, 5.

[96] Boeckh, Public Economy of the Athenians, p. 76. London, 1857.

[97] Ibid. pp. 110, 117.

[98] Plutarch, Pericles, 37.

[99] Aristotle, Economics, II, 34. Demosthenes, *Cóntre Parmenis*, *Oeuvres Completes*, vol. IV, p. 229. Trans. by Abbé Auger, Paris, 1777.

Sicily was a resource for Athens when grain exports from Egypt failed, owing either to a low Nile or to excessive manipulation of the market, as in the case cited. The familiarity of Nicias and Alcibiades with the Sicilian wheat supply in 415 B. C. indicates that Athens, like Sparta, had long imported breadstuffs from that island. The Sicilian wheat was the heaviest brought into Greece, and ranked just below the native Boeotian product.[100] Hellenic grain ships sought the markets not only of the Greek colonies in eastern Sicily, but visited also the Phoenician ports in western Sicily. "The great advantages and profits" which they drew thence[101] can be attributed in part to dealings in grain, for this district exported wheat to Carthage.

The Thracian wheat which Theophrastus was familiar with in Athens probably came chiefly from the Strymon Valley and the neighboring coastal plain as far as the Nessus River. This district was known in ancient as in modern times as fertile and well watered; it was rich in grain fields, forests, and gold mines.[102] Athens seized the coast fortress of Eion near the Strymon mouth from the Persians in 475 B. C.; tempted by the local resources, it made an unsuccessful effort in 465 B. C. to plant a colony at the bridge of the Strymon just above Eion, where thirty years later Pericles established the thriving emporium of Amphipolis.[103] That grain formed one of the exports of Amphipolis is suggested by the fact that about 286 B. C. the king of Paeonia, a country of the upper Strymon and Axius valleys, presented 10,000 Attic medimni of grain as a gift to the Athenian citizens.[104] Other Thracian wheat may have come to Athens from its allies Selymbria and Perinthos, either direct or through the market of Sestos. The East Thracian fields, which were very productive,[105] were probably cultivated by the Hellenized natives who maintained commercial relations with the coasts, because most of the Thracians were engaged in herding in the time of Herodotus.[106]

Importance of the Pontic Markets.—The northern coastlands of the Pontus Euxine became Attica's chief source of wheat, though other Hellenic states were the pioneer traders on those remote shores. The Hellespontine policy of Pisistratus indicates that Athens began her commercial ventures there at the beginning of the sixth century B. C. Her maritime empire established in the age of Pericles drew all the Hellenized shores of the Euxine into her alliance, and opened every

[100] Theophrastus, *Historia Plantarum*, Bk. VIII, ch. IV, 3.
[101] Herodotus, VII, 158.
[102] Pliny, *Historia Naturalis*, XLV, 30. Strabo, Bk. VII, ch. VII, 5; Fragment 36.
[103] Bury, History of Greece, pp. 336, 382. 1909.
[104] Boeckh, Public Economy of the Athenians, p. 124. 1857.
[105] Aristotle, Economics, II, 27.
[106] Herodotus, V, 6.

port to her trade. Pericles toured this northern sea to consolidate commercial and political relations by a display of Athenian naval power;[107] for the growth of Athens necessitated increased grain and wood imports from the Pontic shores. In the time of Demosthenes, Leucon, King of the Crimean Bosporus, supplied Athens yearly with 400,000 medimni (600,000 bushels), or nearly half its total annual import of grain.[108] The total import was therefore over 800,000 medimni or 1,200,000 bushels. One year, however, probably in 360 B. C. during the famine of the 105th Olympiad when, as Demosthenes implies, the grain shipments from Theodosia were extraordinarily large, Leucon shipped to Athens 2,100,000 medimni or 3,150,000 bushels.[109]

While the official dealings of Athens were largely with the Crimean grain market of Theodosia, wheat was brought to the Piraeus by foreign merchants from the wide plains of the Dnieper (Borysthenes) and Bug (Hypanis). On the peninsula formed by the confluence of these two rivers stood a temple of Ceres, a seamark on this low coast pointing the way to the grain market of Olbia, which was founded by Miletus and became a wealthy city like the modern Odessa. The Greeks considered the Dnieper district comparable to the Nile valley in productivity.[110] On the Dniester they founded the colony of Tyras,[111] doubtless as a wheat port. The work of tillage was done by Scythian nomads, who became partly Hellenized and settled down to cultivate land for the Greek grain fleets.[112] This Pontic wheat included a hard spring wheat and a soft, light winter wheat. Theophrastus states that both a winter and spring sowing of all grains were made in that country; but as he describes the Pontic wheat in general as very light, importations of winter wheat must have predominated.[113] It therefore came chiefly from the southern and western grain fields of the Pontic littoral, for these are the only sections which to-day have enough snow to blanket the winter fields.

The Pontic coast lands offered profitable fields of trade to the industrial and commercial cities of the Aegean. They were a sparsely populated region of raw production, abounding in the produce of forest, field, pasture and fishing grounds. They yielded not only cereals in abundance, but cattle, hides, wool, salt fish, and timber from the Caucasus. For these the Greek city-states, commanding at home scant wheatlands, scant forests, scant pasturage, exchanged the finer products of the south,—olive oil, wines, potteries, woolen goods and clothing.

[107] Plutarch, Pericles, XX.

[108] Demosthenes, *Contre Leptines, Oeuvres Complettes*, vol. III, p. 9. Paris, 1777.

[109] Strabo, Bk. VII, ch. IV, 6.

[110] Herodotus IV, 53, 78. Strabo, Bk. VII, ch. 3, 17.

[111] Herodotus, IV, 51.

[112] Herodotus, IV, 17, 18.

[113] Theophrastus, *Historia Plantarum*, Bk. VIII, IV, 5.

Ships sailed with full cargoes on outbound and homebound voyages, and earned big profits. The Pontic shores, owing to a cold climate and to a backward civilization, afforded better selling markets than Egypt or Sicily; for Sicily, after three centuries of colonization was Hellenized on the eastern side by the time of the Peloponnesian War.

Athenian Control of the Pontic Trade Route.—Forced by her geographic conditions into a precocious industrial and commercial development, Athens early recognized her need of these Pontic markets. About 600 B. C. she seized Mytilene's fortress of Sigeum at the entrance to the Hellespont,[114] probably with the purpose of interfering with Megara's trade in Pontic wheat. In 535 B. C., Pisistratus inaugurated a regular Hellespontine policy aiming at access to the Euxine, and from this policy Athenian statesmen never thereafter deviated. It consisted in augmenting Athenian influence and multiplying Athenian colonies along the Hellespont, Propontis and Bosporus, in order to control this whole strategic passage. The Delian League gave her eventual possession of Lemnos, Imbros and Tenedos, which commanded the Aegean approaches to the Hellespont, and on these islands she rarely loosened her grip. Her line of communication as far as Lemnos was maintained by control of Euboea, which safeguarded the marine Broadway of the Euboean Sound, and by the possession of the islands of Sciathos, Peparethos and rocky Halonnesos. The latter had no value except as an island way-station on the voyage to the Hellespont, though in hostile hands, like those of Philip of Macedon, it threatened the wheat track.[115]

The economic and political life of Athens depended upon her ability to maintain this line of communication; of this fact the state was vividly aware. At the close of the Persian War, Athens sent its fleet to the Hellespont and drove the enemy from Sestos (478 B. C.), which controlled the narrows of the strait, thus clearing the way for future ascendency there.[116] Two years later, when the Spartan Pausanias occupied Byzantium and Sestos, an Athenian fleet under Cimon promptly dislodged the intruder from both positions. After the maritime empire of Athens was established by Pericles, her enemies came to see that her vulnerable spot lay in the straits where her communication with the Pontic grain fields and forests could be most effectually interrupted. Therefore in the latter years of the Peloponnesian War, naval engagements multiplied in the Hellespont, as Athens made a fight for her life. Finally her fleet was wiped out by the Spartans in the battle of Aegospotamos near Sestos in 405 B. C. Ernst Curtius

[114] Herodotus, V, 94, 95.
[115] Demosthenes, Oration on Halonnesos.
[116] Herodotus, IX, 114-118.

surmises that this battle occurred in summer, not later than August, at the peak of the season when the Pontic grain ships were hurrying south, in order to reach their home ports before the September storms should stop navigation.[117] The Spartan Lysander probably selected the critical moment to close the Hellespont, and that with dramatic effect. The Athenian sacred galley escaped from the battle and carried the news to Athens. Xenophon describes the scene which ensued. "At Athens, on the arrival of the Paralus in the night, the tale of their disaster was told; and the lamentations spread from the Piraeus up the long walls unto the city, one man passing on the tidings to another; so that night no man in Athens slept."[118]

Ten years later, when Athens revived and established the Athenian Confederation (395 B. C.) to operate against Sparta, she first secured the alliance of Lemnos and Imbros, island warders of the Hellespont. In 389 B. C. she began to get control over the sea route to the Euxine by drawing into her alliance Samothrace, Lesbos, various Hellespontine cities, Byzantium and Chalcedon, and raised a revenue by imposing tolls on merchandise passing through the Bosporus. Again the straits became the scene of hostilities between Athenians and Spartans, till in 387 B. C. the Athenian fleet was blockaded in the Hellespont and the Pontic grain vessels were cut off from the Aegean.[119] The second Athenian Confederacy (378 B. C.) comprised Byzantium, various Thracian cities, Lesbos, and most of the Euboean towns, all stations on the sea route to the Euxine, besides Rhodes and Chios, who as small island states were vitally interested in the Pontic trade. This time the Spartan fleet did not go so far as the Hellespont, but hovered about Aegina, Andros and Ceos, on the sea approaches to the Piraeus. There they blocked the advance of the grain ships, which had reached the southern end of Euboea, and prevented their rounding Cape Sunium, till the Athenians fitted out an emergency fleet, defeated the Spartan triremes, and brought in the grain to their starving populace.[120] The approaches to the Saronic Gulf offered many strategic points for intercepting the Athenian grain ships. Therefore Athens made Sunium a fortified naval base during the Peloponnesian War to protect this last perilous thirty-mile stretch up to the Piraeus.[121] The outer sea-gate to the Saronic Gulf had the island of Andros and the seaport of Carystus in south Euboea as its keepers. In order to safeguard the strategic passage, therefore, almost the first act of the Delian League was to reduce Carystus in 471 B. C., and force its entry into the con-

[117] E. Curtius, History of Greece, vol. III, p. 591, note XI. 1872.
[118] Xenophon, Hellenes, Bk. II, ch. II, 3.
[119] Bury, History of Greece, pp. 546, 550-552.
[120] Xenophon, Hellenes, Bk. V, ch. IV, 60-61.
[121] Thucydides, VIII, 4.

federation.[122] When Athens converted the League into an empire, she took the further precaution of settling cleruchies or out-colonists in Andros to secure the loyalty of that island (447 B. C.).[123]

Whoever fought Athens had to strike at her overseas grain trade. Therefore her next rival, Thebes, was forced out of her normal character as a land power and assumed the novel rôle of a sea power; built a hundred triremes, and sent them to the Propontis to prey upon the Pontic grain ships (364 B. C.). While Athens from her base at Sestos endeavored to defend these, the Theban admiral adopted the obvious policy of stirring up the Hellespontine cities of the Chersonnesus against Athens, and alarming King Cotys of Thrace with predictions of Athenian conquests. Cotys seized Sestos and nearly the whole Chersonnesus in 360 B. C. His death soon after and the decline of Thebes enabled Athens to recover control of the Hellespont in 357 B. C., when she again drew Euboea into her alliance.[124] Thus, with her old possessions Lemnos and Imbros, she restored the security of the grain track from the Propontis to the Piraeus, and fortified herself for her next big struggle.

Philip of Macedon was the next rival to Athens. The chief actor in the drama changes, but not the scenes or the dramatic episodes. These recur with historical monotony due to the same controlling geographic conditions. There was the same old struggle for the control of the Bosporus, the Hellespont and the wheat emporiums of the Thracian coast,—Byzantium, Selymbria, and Perinthos. Macedon, like Thebes, was forced to become a naval power. She let loose her triremes to capture Athenian wheat transports in the north Aegean and to harry Lemnos, Imbros, and Euboea. There the Macedonian forces seized Eretria and fortified Oreus at the northern end of the island, in order to dominate the stormy and dangerous entrance into the Euboean Sound.[125] Philip's land campaigns aimed at the conquest of Thrace, from Byzantium to the tip of the Chersonnesus, where Athens was most vulnerable. He endeavored to conquer Athens in Thrace, as Napoleon endeavored to conquer England in Egypt. The arguments of Demosthenes to arouse Athens to the gravity of the danger paralleled those used in the British Parliament for the continuance of the French war. Demosthenes, enumerating his provisions for Athens' safety, gives a digest of the geography and the strategy of the war. By the recovery of lost Euboea he protected the Attic seaboard and the grain track through the Euboean Sound. Effecting the release of Byzantium, the Chersonnesus and Halonnesos from Mace-

[122] Bury, History of Greece, p. 337. 1909.

[123] Plutarch, Pericles XI.

[124] Bury, History of Greece, pp. 615-617, 682-683. 1909.

[125] Demosthenes, Oration on the Chersonnesus, and First Philippic.

donian dominion, he opened the Hellespont and Bosporus for the passage of the Pontic grain ships, and provided for their conveyance along a friendly coast all the way to the Piraeus. He persistently exhorted the citizens to expand and strengthen the navy, with which to guard these overseas connections.[126]

THE TASKS OF THE ATHENIAN NAVY.—Athens was the Britain of the ancient Mediterranean. Its navy alone guaranteed the full loaf of bread. Fleets had to police the Pontic wheat track against the Caucasus pirates, and suppress other sea-robbers who recurrently infested the routes to Egypt and Sicily. A strong navy was necessary to check sporadic depredations on the merchant ships by rival powers even in time of peace. Chalcedon, embarrassed by an empty treasury, once utilized its location on the Bosporus to plunder some vessels going north into the Euxine,[127] doubtless loaded with manufactured goods with which to pay for the return cargo of wheat and fish. While Philip of Macedon was besieging Selymbria in eastern Thrace, his fleet captured twenty Athenian grain ships passing through the Propontis to the Hellespont *en route* to Lemnos, because the Macedonian admiral suspected that the supplies were meant for the besieged city.[128] Again early in the reign of Alexander the Great, Pontic ships were arbitrarily seized by the Macedonians and held up at Tenedos, though freedom of the seas and security of ships against seizure had been pledged by Alexander's recent treaty with Greece. Athens' prompt equipment of a large naval fleet led to the release of the captured vessels.[129]

In time of war, naval convoys attended not only the wheat fleets of Athens but those of any member of the Athenian Confederacy. For this protection an annual tribute was paid.[130] Hostile attacks were not limited to the mere seizure of food vessels. When Demetrius of Macedon was besieging Athens about 300 B. C., he captured a wheat transport bound for the Piraeus, and hanged the captain together with the pilot. This treatment so terrified the merchants that they stayed away and let Athens starve till she surrendered to Demetrius.[131]

COMMERCIAL TREATIES AND ALLIANCES.—At all times the gloved hand of diplomacy aided the mailed fist of the navy. In the age of Pericles, and again in the time of Demosthenes, the international policy of Athens was dominated by the economic interests of the State. In the Euxine Athens held the friendship of the Greek towns by giving

126 Demosthenes, Oration on the Crown.
127 Aristotle, Economics, II, 11.
128 Demosthenes, Oration on the Crown, and the Letter of Philip.
129 Demosthenes, Treaty of Alexander.
130 Demosthenes, Oration on the Chersonnesus.
131 Plutarch, Demetrius, XXXIII.

them support against barbarian attacks. With the reigning house of the Cimmerian Bosporus she maintained close relations based upon reciprocity of trade. Leucon, prince of Panticapaeum from 393 to 353 B. C., exempted Attic ships from the export duty, allowed them to purchase grain ahead of other ships, and fixed a market for them in the excellent port of Theodosia near the Crimean wheat fields.[132] Athens convinced him that she was his best customer, and conferred honors upon him. She also cultivated friendship with the powers of the Thracian Bosporus and Propontis; with the Persian satrap of Hellespontine Phrygia, who by reason of geographical location could imperil or police the southern strait; with the barbarian kings of eastern Thrace; and with the free cities of Byzantium and Perinthos,[133] who not only occupied strategic positions, but were themselves wheat emporiums.

Byzantium grew rich on her Pontic trade. It was an obvious policy for the cities of the Propontis and straits to accumulate grain, either by direct importation from the Euxine or by the levy of port dues and Bosporus tolls, paid in kind,[134] on passing ships; they could then resell it to merchants who were unwilling to make the long voyage to the Crimea, or who arrived near the end of the sailing season and wished to return home before the autumn storms. Thus we read that Heraclea, located on the Thracian coast north of the Chersonnesus, sent forty ships to the Crimean Bosporus to buy wheat and other supplies.[135] Sestos was called in Athens "the wheat-bin of the Piraeus,"[136] a term applicable only to a grain emporium. Its strategic location at the narrows of the Hellespont made it not only a base for military control, but also like Byzantium a natural toll station which Athens sometimes used for collecting transit dues, levied in kind, if we may judge from Leucon's export taxes on the Pontic wheat. Athens showed persistent friendship for Egypt and Cyprus by assistance rendered to these states when revolting against Persian dominion. Her motive may have been partly her old hostility to the Great King, but partly also her need of Egyptian and Cyprian grain.

Government Control of the Athenian Grain Market.—The grain market of the Athenian Agora, despite all government measures to insure a steady supply of wheat and barley, was sensitive to every political movement in Scythia and Thrace, to every disturbance in the towns of the Bosporus and Hellespont. Prices fluctuated according to

[132] Demosthenes, *Cóntre Leptines, Oeuvres Complettes*, vol. III, pp. 19-20. Paris, 1777.

[133] Demosthenes, Letters of Byzantium and Perinthos in the Oration on the Crown.

[134] Xenophon, Hellenes, Bk. I, ch. I, 22. Polybius, IV, 44, 46.

[135] Aristotle, Economics, II, 9.

[136] Aristotle, Rhetoric, III, 10.

the seasons, as these were favorable or unfavorable to crops and to navigation; they fluctuated as importations increased or diminished, as export duties were raised or lowered in the grain emporiums of the Mediterranean, and as the markets were cornered both within and without Attica and prices arbitrarily raised. War and piracy always made the grain business in the Piraeus feverish. The fluctuations, however, were not excessive except during a siege or sudden threat of war. In the time of Pericles and Socrates, the medimnus of prepared barley cost normally two drachmae or 34.2 cents, and wheat was probably a third more. In 396 B. C. wheat sold for three drachmae or 51.3 cents, and fifty years later in the time of Demosthenes for five drachmae or 85.5 cents.[137] Prices in other Greek states were about the same. At Lampsacus the normal price for a medimnus of wheat in Aristotle's time was four drachmae or 68.4 cents, but this was arbitrarily advanced by the State to six drachmae, or $1.02 at a threat of war, doubtless as a hint for conservation.[138]

The cheapest and best market in which the Athenians could buy was that of the Crimean Bosporus. There excellent rates were given even in time of scarcity. At Olbia on the Dnieper estuary, prices were variously two, four and eight drachmae or 34.2 cents to $1.37 in the first or second century B. C., but they must have been lower in the fifth and fourth centuries B. C. Prices in Egypt were low, reflecting the fertile soil, large arable area, cheap labor, and the relative certainty of harvest under irrigation tillage. In the time of the Ptolemies the normal price for spelt and wheat was about two drachmae or 34.2 cents the medimnus, and in times of scarcity it increased hardly threefold. Shortly after the founding of Alexandria, however, under the satrap Cleomenes, the wholesale price of wheat rose to ten drachmae or $1.71 in a time of scarcity. Sicilian grain was doubtless cheap prior to the Roman conquest of the island. In 74 B. C., the price of wheat there was fixed at an equivalent of 91.2 cents and barley at 45.6 cents the medimnus.[139]

The vicissitudes of the grain trade, due largely to geographic conditions, necessitated governmental control. Even Egypt found it necessary in years of reduced crops to prevent exports, either by direct inhibition or by imposition of enormous export duties.[140] Selymbria, though located in a wheat-growing district of Thrace, prohibited grain exports in time of scarcity.[141] Athens during the Peloponnesian War employed her control of the Bosporus and Hellespont to allow no grain

[137] Boeckh, Public Economy of the Athenians, pp. 128-129. 1857. Demosthenes, Oration against Phormion.

[138] Aristotle, Economics, II, 8.

[139] Boeckh, Public Economy of the Athenians, pp. 130-132.

[140] Aristotle, Economics, II, 34.

[141] Ibid., II, 17.

exports from the Euxine or Byzantium, except by express permission as to the destination and annual amount.[142] She thus waged an economic war against her ill-fed enemies like Corinth, Megara and Sparta, and used her command of the Pontic grain as a means to hold the allegiance of her restless insular allies, like Rhodes, Cos, Chios and Lesbos.

At all times the grain trade of the Piraeus was closely controlled, as was also the sale of lumber and ship supplies; otherwise the commerce of Athens was free. The exportation of native grain from Attica was prohibited by law. Furthermore, two-thirds of every cargo of foreign grain entering an Attic port had to remain in the country. No inhabitants of Attica, whether native or alien residents, might transport grain to any other but Attic ports; nor might they so much as loan money on the security of a vessel, unless such vessel should return to Athens with a cargo of grain or other commodities. The object of these measures was to compel importations of foreign grain. Furthermore Athens appointed certain officials who kept account of the imported grain, and saw to it that two-thirds of the supply should be brought to the city from the ports. She provided public storehouses for the state-owned grain, and also for the stock of private dealers. Government commissioners purchased grain for the state, while yet others received and measured it.[143] Thus a reserve was at hand in time of emergency, to be sold to the populace at a moderate figure and to stabilize prices. Probably some of it was given to the citizens. Measures were also adopted to prevent dealers from cornering the market. Retailers might sell only at the advance of one obolus, or about three cents on the cost price of a medimnus, though in time of dearth they ran up the prices and sold at six times the legal profit. Eager to profit by every fluctuation in the market, the grain dealers spread alarming rumors to send up the price of wheat, saying that the grain ships had been wrecked in the Euxine or captured at sea by the Spartans, that commercial treaties had been violated and the grain ports closed against Attic merchantmen, with the result that the nervous populace was willing to buy at any price. To curb these enemies within the state, Athens imposed a death penalty for any effort to establish a grain monopoly.[144] The free foreign dealers regularly bought grain in the cheapest market and sold in the highest, and with this purpose they scoured the Aegean, the Euxine and the Sicilian coasts.[145] Athens made every effort to attract them to the Piraeus

[142] Boeckh, Public Economy of the Athenians, p. 78.

[143] Ibid., 78–78, 114-116, 121-123.

[144] Lysias, *Cóntre les Commercans de Blé, Oeuvres Complettes*, pp. 304-305. Trans. by Abbé Auger, Paris, 1783.

[145] Xenophon, *Oeconomicus*, XX, 27-28.

market; this rich and populous state was in a position to pay well for the needed breadstuffs, but it encouraged competitive selling.

It is reasonable to suppose that other states, possessing similar geographic conditions to those of Attica, and therefore compelled to import overseas grain, adopted similar foreign and domestic policies to maintain a balance of breadstuffs and population. The abundant literature of Athens enables us to reconstruct in considerable detail the constant efforts of the state to fill its grain-bins. Megara, located astride of the Isthmus of Corinth with a port on each side, maintained connection with the Sicilian fields as well as with the Pontic wheat lands, as indicated by her colonies both in Sicily and on the Bosporus. Corinth early in the eighth century B. C. established trade relations westward with Syracuse and other Sicilian wheat markets. Mountainous Achaia, located on the marine highway of the Corinthian Gulf[146] and having easy access to the west, imported grain from Sicily and doubtless also from her Italian colonies in the fertile plains of Sybaris and Croton. The island states of the Aegean, like Rhodes, Chios and Cos, seem to have relied chiefly on the Pontic grain. They therefore rushed to the support of Athens whenever the Euxine connection was jeopardized. Their interests were identical, and therefore they were nearly always members of the various Athenian confederacies. After the decline of Athens, Rhodes became the chief maritime power of the Aegean. In 228 B. C., we find her heading all the states interested in the Pontic trade in a war against Byzantium, which had got astride of the Bosporus by the acquisition of territory on the Asiatic side, and was levying a toll on all goods brought from the Pontus.[147] As Rhodes and her island confederates assisted Athens and Byzantium against the expanding power of Philip of Macedon, in 340 B. C., in his effort to control the straits, so in 201 B. C. the Rhodian League joined the King of Pergamos and the Romans to prevent Philip V. from attaining a like purpose.[148]

Wheat Production in Western Mediterranean Lands.—In the lands of the Western Mediterranean, geographic conditions were more favorable to wheat culture than in the Eastern Basin, apart from the Pontic and Egyptian fields, which lay outside the Mediterranean climatic region. The rainfall was in general greater, more reliable, and lasted longer. Hence the farmers' crops were less jeopardized by failure of the autumn and spring rains. Tertiary and Quaternary plains, though no larger, were more evenly distributed. In Sicily and parts of Italy disintegrated lava, tufa, and volcanic ash lent

[146] Theophrastus, *Historia Plantarum*, Bk. VIII, ch. IV, 5.

[147] Polybius, IV, 39, 46, 47, 50.

[148] Mommsen, History of Rome, vol. II, p. 411. 1905.

exuberance to the fertility of the soil, and enabled it to retain the moisture necessary for the maturity of the crop during the dry period before the harvest. Sicily was an important granary from very ancient times, and produced wheat that almost equalled the Boeotian grain in nutritive quality. Theophrastus attributed the heavy crops to the frequent spring showers of Sicily.[149] Strabo states that its wheat, honey and saffron surpassed that of Italy.[150] Its grain exports went to Greece certainly at the beginning of the 5th century B. C., and probably earlier. During the time of Agathocles of Syracuse, about 310 B. C., Carthage imported wheat and other provisions from Sicily and Sardinia, securing this traffic by her control of the sea. Agathocles, at war with his Punic neighbor, planned to break up this grain trade and equipped a fleet for the purpose.[151]

Early Roman Grain Trade.—Rome imported Sicilian wheat from the beginning of the Republic. Ordinarily the fertile plains of the lower Tiber and Anio sufficed for the agricultural communities which constituted the ancient Latin League and the early Roman state; but during periods of drought which destroyed the harvests, or of sustained war, which interrupted tillage and devastated the growing crops, importations of wheat and spelt were necessary. Frequently these came from the fertile volcanic region about the Bay of Naples. The moist black earth of Capua and the famous Phlegraean fields about Cumae were considered standard wheat lands by the ancients,[152] and their choice product could be readily transported by sea along the coast to the Tiber mouth. Rome's nearer neighbors, the Hernici of the broad and fertile Trerus River valley, and the Volscii of the upper Liris valley and the Latium coastal plain, possessed good wheat land, and at times they seem to have sold grain to Rome; but they were victims of Roman wars of expansion and therefore generally refused to sell to their ambitious neighbor in her hour of need.[153] Rome therefore often drew upon the abundant grain resources of Etruria, whence wheat could be transported either down the Tiber or along the coast. Etruria is an old volcanic region of rich heavy soil. Its streams drain hills overlaid with trachyte, tufa and basalt, and deposit in the valley plains soil rich in potash, soda and phosphoric acid,—all important articles of plant food.[154] Pliny considered the wheat of Clusium, grown in the lake-strewn basin of the upper Clanis River (Chiana), the best

[149] Theophrastus, *Historia Plantarum*, Bk. VIII, ch. IV, 4; ch. VI, 6.
[150] Strabo, Bk. VI, ch. II, 7.
[151] Diodorus, Siculus, XXI, fragment 12.
[152] Vergil, Georgic II, 217-224. Columella, II, 9. Strabo, Bk. V, ch. IV, 3, 4, 8.
[153] Livy, II, 34.
[154] W. Deecke, Italy, pp. 64, 96, 376. New York, 1904.

in the world. It weighed twenty-five per cent more than Boeotian wheat.[155]

In the early interstate grain trade of Italy, Rome figures as a frequent importer. During a protracted period of famine in 490 and 489 B. C., it purchased grain all along the Etruscan and Campanian coasts and in Sicily. Etruscan grain was also brought down the Tiber, probably from the rich Clusium fields.[156] In 474 B. C., during a scarcity due to a prolonged war with Veii, Rome imported wheat from Campania;[157] in 437 B. C., when evidently a general drought had reduced the harvests, she "sent out embassies by land and sea to all the neighboring states to purchase grain, with little result except that a small quantity was procured in Etruria."[158] In 409 and 408 B. C. Rome was forced by famine and pestilence to import grain from Etruria, the upper Tiber cities and Greek Sicily. She could get none from Campania because the fertile district of Capua and Cumae had just been conquered by the mountain Samnites, who refused to aid their rival neighbor.[159] Etruria continued to be the chief Italian source of supply[160] until Rome established her naval power sufficiently to ensure importations of overseas wheat. The importance of this nearby reliable supply of Etruscan wheat may be inferred from the fact that in 210 B. C., when the grain fields of Campania were in Hannibal's hands, and those of Sicily had been devastated by five years of continual war, Rome's granaries were so depleted that a medimnus of Sicilian wheat sold in Rome for the high price of 15 denarii, or $2.56.[161] At this juncture Rome renewed an old alliance with Egypt, and secured the support of its grain ships to feed Italy and the legions.[162] On the restoration of peace in Sicily, she made extraordinary efforts to revive agriculture in the island for the sake of the wheat.

Territorial Expansion and the Roman Grain Trade.—This second Punic War, which gave Rome command of the sea, demonstrated to the government the possibility of maintaining Italy and her army by wheat from Sicily and Egypt. Then followed a disastrous competition between the small Italian farms and the vast slave estates in the rich wheat lands of Sicily, Sardinia, Numidia, Carthaginian Africa, and the Guadalquivir valley of Spain.[163] Field agriculture in

[155] Pliny, *Historia Naturalis*, XVIII, 7.
[156] Livy, II, 34.
[157] Livy, II, 52.
[158] Livy, IV, 12, 13.
[159] Livy, IV, 52.
[160] Livy, XXVIII, 45.
[161] Polybius, IX, 44.
[162] Mommsen, History of Rome, vol. II, p. 315. 1905.
[163] Strabo, Bk. III, ch. II, 6; Bk. V, ch. II, 7. Pliny, *Historia Naturalis*, XVIII, 10.

Italy declined as the country was flooded with foreign grain. Sea transportation of wheat from Sicily and Sardinia was as cheap as land transportation from Etruria and Campania. The extensive alluvial plain of the Po valley, especially Gallia Transpadana, yielded fine wheat in large quantities,[164] but it was too far from the capital to compete with Sicilian and Sardinian grain. Hence in 150 B. C. wheat sold there for four oboli or twelve cents the medimnus, and barley for two oboli or six cents,[165] owing to lack of a market. The farmers found it more profitable to feed their grain to hogs, fattening the mast-fed pigs till they rivalled modern Berkshires and exporting the hams and bacon to Rome.[166] Meanwhile Sicilian and Sardinian wheat sometimes sold in Rome for the freight charge.[167] The conquest of Spain, especially the fertile Guadalquivir valley, in the Second Punic War placed the Iberian grain at the disposal of Rome. Even in 203 B. C. the government drew wheat both from Spain and Sicily to supply Scipio's army in Africa, while that army, immediately after landing on Carthaginian soil, gathered in the grain from the broad and productive fields of the Bagradas River valley.[168] At the close of the war Rome was selling its citizens Spanish and African wheat at 12 to 24 asses (20 to 40 cents) a medimnus.[169] It procured the grain by tribute and purchase. The Roman army fighting in Macedonia in 170 B. C. was supplied by Carthage with 250,000 bushels of wheat and 125,000 bushels of barley. Numidia sent it an equal amount of wheat which the Roman government bought.[170]

After the annexation of Carthaginian and Numidian Africa and the conquest of Egypt, both the tribute and purchase grain increased in amount, in proportion to the productive area and fertility of these countries. In the time of Augustus, Egypt furnished one-third of the grain consumed by Rome, Africa another third, while Sicily, Sardinia, Spanish Baetica, and Italy's own reduced yield supplied the final third. The grain of Egypt and Africa was so vital to Italy and the Imperial City that these countries became the key to the control of Rome itself. Conquest of either one was equivalent to the conquest of Italy, a fact that was not lost upon the later adventurous aspirants to the throne of the Caesars.[171]

The immense area of the Roman Empire, which finally included all the Mediterranean wheat lands, was the politico-geographical factor

[164] Pliny, *Historia Naturalis*, XVIII, 7.
[165] Polybius, II, 165.
[166] Strabo, Bk. V, ch. I, 12.
[167] Livy, XXX, 38.
[168] Livy, XXX, 3.
[169] Mommsen, History of Rome, vol. III, p. 76. 1905.
[170] Livy, XLIII, 6; XLV, 13.
[171] Mommsen, Provinces of the Roman Empire, vol. II, pp. 260, 366-7. 1887.

which stimulated grain importations into Italy and discouraged native agriculture. Italy's focal location in the Mediterranean Sea was a second geographic factor operating to the same end. It facilitated maritime movements of grain from all the big areas of production and on a scale impossible in a land empire in ancient times. Italy's location was comparable to that of the Attic peninsula in the Eastern Basin, and was conducive to similar economic effects. The maintenance of these systematic importations depended upon the security of the sea-ways between the wheat countries and the Roman markets, and therefore upon the efficiency of the navy. The decline of Roman sea power from 102 to 67 B. C. fatally weakened the marine police. Pirates so infested the grain tracks that between 75 and 67 B. C. imports ceased, and the price of wheat at Rome soared to 120 sestertii or $4.65 the medimnus, or about ten times the market price in Sicily.[172] Therefore when Pompey was appointed dictator of the sea in 67 B. C., his first act was to clear the waters about Sicily, Sardinia and Africa, in order to restore the movement of wheat from those provinces to Italy; his next was to suppress the Cilician pirates, who issued from their convenient lairs along the Taurus Mountain littoral and infested the wheat route from Egypt passing their doors.[173]

Imperial Rome and Athens owing to quite different causes were both singularly dependent upon overseas grain lands. The vulnerable spot of Athens' sea empire lay in the Hellespont; that of Rome's land empire lay in Africa and Egypt. While Athens was constantly fighting rival Greek commonwealths, whom she was powerless to conquer because of her small land base and the nature-made individualism of the Greek states, Rome eliminated her foreign enemies by the *pax Romana,* but left sea pirates who captured her grain ships, and political pirates who seized the imperial throne by possessing themselves of her chief grain lands. There was perhaps never a time that ancient Italy could not have fed itself from its home fields, except in the rare years of drought. There was never a time that Athens could have fed itself, unless it established a maritime power supported by some measure of political power, as evinced in the various Athenian confederacies. Rome's expansion aimed always at more territory; an imperial parasite, she lived off of the newly acquired lands as Athens never lived off of Euboea or Thrace or Crimea. Therefore Rome's grain lands became a bludgeon in the hands of candidates for the imperial throne.

[172] Cicero, Verres, 92, 214.

[173] E. C. Semple, The Pirate Coasts of the Mediterranean, Geog. Rev., vol. II, pp. 134-151. New York, 1916.

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THE CLIMATE OF SOUTHEASTERN IDAHO[1]

GEORGE ROGERS MANSFIELD

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INTRODUCTION.—A study of the climate of southeastern Idaho was made by the writer as a phase of the U. S. Geological Survey's investigation of the Idaho phosphate field. The results are deemed of sufficient interest to warrant separate publication.

As shown in the accompanying map (Fig. 1), the region extends northward along the Wyoming line from lat. 42° to about lat. 43° 30′ and westward from about long. 111° to about long. 112° 30′. It includes the actual southeast corner of Idaho and a narrow strip of western Wyoming as far east as the base of the Salt River Range. The region is generally mountainous with ranges that trend northward or northwesterly, but it contains a number of broad, intermontane valleys, such as Bear Lake Valley, and to the northwest it descends to the Snake River Plain. The altitudes of the larger valleys range from 4500 to about 6200 feet and the mountains rise 2000 to 3000 feet higher.

Climatological data for 16 stations within the region here described are given in publications of the United States Weather Bureau.[2] At some of these stations records have been kept continuously for periods as great as ten or twenty years. At others the records have been discontinued after longer or shorter intervals. At still others the records have been kept for so short a time that they have as yet little value in climatological studies. There is also considerable variation in the degree of completeness of the records at the several stations.

In order to show the variety of climatic conditions in different parts of the region some of the more important records of all these stations are given in tables below. In these tables the records summarized in the first publication cited above, which include data for the years up to and including 1914, have been corrected to the close of the year 1919, by interpolation of data from the other volumes cited.

[1] Published by permission of the Director of the United States Geological Survey.

[2] Summary of climatology of the United States by sections: U. S. Dept. Agriculture, Weather Bureau Bull., W, secs. 22 and 23, 1912; also Climatological data of the United States by sections, vols. 1-6, 1914-1919 incl.

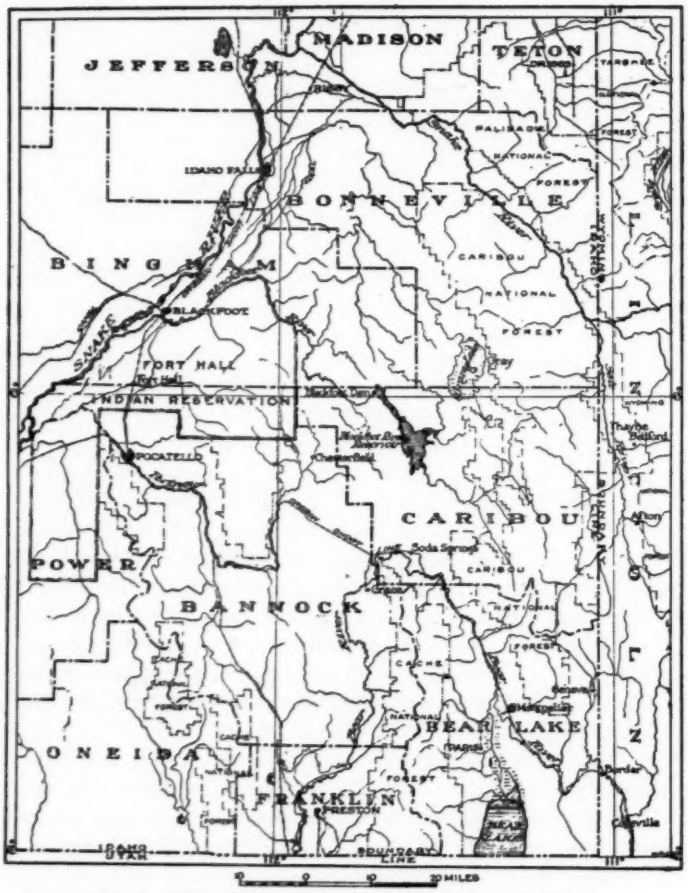

FIG. 1.—Map of the region showing location of stations

From these later volumes also the data for the new stations have been compiled. The location of the stations is shown in Fig. 1.

DESCRIPTION OF TABLES.—Table 1 gives the names, locations, and elevations of the several stations, together with the lengths and limiting dates of their records. Table 2 gives the monthly and annual mean precipitation at each station in inches and hundredths. Table 3 gives the average number of rainy days (days with .01 inch or more of precipitation) at each station for each month and for the year. Table 4 shows the average snowfall (unmelted) in inches. Tables 5, 6, and 7 give respectively the highest, lowest, and mean temperature recorded

TABLE 1—CLIMATOLOGICAL STATIONS OF THE REGION

Station	Location	Elevation Feet	Length of Record	
			Years	Dates
Afton.....	Lincoln Co., Wyo., on Swift Creek at the east side of Star Valley (6 miles wide) and at the west base of the Salt River Range. Afton quadrangle.	6,200	17	1903–1919 (Some months missing)
Bedford....	Lincoln Co., Wyo., near Strawberry Creek in Lower Star Valley a mile and a half from the west base of the Salt River Range. Afton quadrangle.	6,200	21	1899–1919 (A few months missing)
Blackfoot Dam...	Caribou Co., Ida., near north end of Blackfoot River Reservoir on Blackfoot lava field. Low mountains rise at distances of 1½ to 3 miles. Cranes Flat quadrangle.	6,150 (6,129 U.S.G.S. B.M. at dam.)	10	1915–1919 (Some years missing)
Border.....	Lincoln Co., Wyo., on state line in valley of Bear River about ¼ mile from north slope of Bear River Plateau and about ½ mile from the river. Montpelier quadrangle.	6,073 (U.S.G.S. B.M. at Border.)	18	1902–1919
Chesterfield	Bannock Co., Ida., on Twenty-four Mile Creek at the northeastern side of Portneuf Valley (4 miles or more wide) and at the west base of the Chesterfield Range. Portneuf quadrangle	5,454 (U.S.G.S. B.M.)	22	1915–1919 (Some years missing)
Cokeville...	Lincoln Co., Wyo., in the valley of Bear River near the rocky gap by which Smith's Fork enters the valley.	6,204	10	1910–1919
Fort Hall...	Bingham Co., Ida., on Ross Fork of Portneuf River and on the Gibson terrace east of Snake River in the Fort Hall Indian Reservation.	4,500	5	1915–1919
Geneva....	Bear Lake Co., Ida., in the northern part of Thomas Fork Valley. Mountains rise on either side at distances of 1 to 1½ miles. Montpelier quadrangle.	6,171 (U.S.G.S. B.M.)	6	1915–1916 (Records very incomplete)

TABLE 1—CLIMATOLOGICAL STATIONS OF THE REGION—Continued

Station	Location	Elevation Feet	Length of Record	
			Years	Dates
Grace.....	Bannock Co., Ida., in the northern part of Gentile Valley, near the west base of the Bear River Range.	5,400	12	1915–1919 (Records very incomplete)
Grays Lake.	Bonneville Co., Ida., on the east side of Grays Lake and at the west base of the Caribou Range.	6,300	3	1917–1919 (Some months missing)
Idaho Falls.	Bonneville Co., Ida., on Snake River, about 3 miles west of the foothills of the Caribou Range in the Snake River lava plain.	4,742	25	1880–1919 (Some years missing)
Montpelier.	Bear Lake Co., Ida., at the mouth of Montpelier Canyon on the east side of Bear Lake Valley, there about 5 miles wide, and at the west base of the Preuss Range, Montpelier quadrangle.	5,943 (U.S.G.S. B.M. 5,963)	5	1915–1919
Paris.....	Bear Lake Co., Ida., on the west side of Bear Lake Valley, there about 9 miles wide, and immediately east of the foothills of the Bear River Range, Montpelier quadrangle.	5,946 (U.S.G.S. B.M. 5,966)	16	1893–1908 (Some months missing)
Pocatello...	Bannock Co., Ida., in the lower part of the canyon of Portneuf River with high hills to northeast and southwest and canyon extending from southeast to northwest.	4,483	20	1899–1919 (Some years missing)
Pocatello Nursery.	Bannock Co., Ida., detailed location not stated.	5,396	12	1908–1919 (Records very incomplete, several years missing)
Thayne....	Lincoln Co., Wyo., in Lower Star Valley about 4 miles west of the Salt River Range and 1 mile east of the Caribou Range. Freedom and Afton quadrangles.	5,900	8	1899–1906

TABLE 2. PRECIPITATION AT 15 STATIONS IN WYOMING AND IDAHO: MONTHLY AND ANNUAL MEANS

(in inches and hundredths)

Station	Av. length of available record years	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Annual	
		yrs	in.	yrs	in.	yrs	in.	yrs	in.	yrs	in.	yrs	in.	yrs	in.	yrs	in.	yrs	in.	yrs	in.	yrs	in.	yrs	in.	Years complete	in.
Afton	14.0	13	1.50	15	1.52	15	1.69	16	1.40	15	2.29	14	1.29	14	1.26	14	0.98	13	1.47	12	1.90	13	0.72	15	1.25	13	17.27
Bedford	19.3	20	2.02	20	1.74	17	1.64	20	1.42	20	2.32	18	1.60	20	0.94	20	1.08	19	1.56	17	1.71	19	1.16	21	1.40	19	18.59
Blackfoot Dam	4.8	5	1.15	4	2.03	4	1.30	5	1.03	5	1.79	5	0.80	5	0.99	5	0.50	5	1.68	5	1.58	5	0.91	5	1.60	4	15.36
Border	17.9	18	1.38	18	1.41	18	1.19	18	1.46	18	1.45	17	1.26	18	0.56	18	0.82	18	1.13	18	1.16	18	0.81	18	0.70	17	13.33
Chesterfield	3.4	4	0.96	4	1.63	4	1.14	4	1.65	3	2.32	4	0.79	4	1.32	4	0.40	3	1.26	3	0.79	2	1.08	2	1.31	0	14.65
Cokeville	10.0	10	1.10	10	1.08	10	0.93	10	1.23	10	1.16	10	1.04	9	0.89	9	0.56	10	1.42	11	1.18	10	0.84	11	0.65	8	12.08
Fort Hall	4.9	4	0.50	5	0.81	5	1.13	5	0.80	5	1.65	5	0.41	5	0.58	5	0.45	5	1.12	5	1.05	5	0.56	5	0.51	4	9.57
Geneva	2.0	2	1.47	2	0.60	2	0.90	2	0.35	2	1.93	2	0.74	2	0.36	2	0.42	2	1.61	2	0.27	2	0.90	2	1.14	2	10.69
Grace	4.3	5	0.62	4	1.11	5	0.76	5	0.95	5	1.82	3	0.37	5	0.72	5	0.70	5	0.74	4	1.02	3	0.87	3	1.60	2	11.28
Grays Lake	2.1	3	1.58	2	1.38	2	1.52	1	0.97	2	2.88	3	0.49	3	1.21	2	0.51	1	1.85	1	1.13	2	1.22	3	1.12	0	15.86
Idaho Falls	18.3	18	1.56	18	1.27	19	1.80	19	1.08	19	1.73	19	1.16	18	0.58	18	0.76	18	0.77	18	0.98	17	0.94	19	1.16	15	13.79
Montpelier	4.8	5	0.89	5	1.98	5	1.08	5	1.28	5	1.39	5	0.65	5	0.56	5	0.58	5	1.28	5	1.36	4	1.03	4	0.74	4	12.82
Paris	12.6	14	1.27	11	0.87	12	1.55	11	1.42	14	1.36	13	0.71	12	0.60	13	0.85	12	0.89	13	0.97	12	0.91	14	1.03	8	12.43
Pocatello	14.5	14	1.09	14	1.35	14	1.76	14	1.35	14	1.65	14	0.85	15	0.48	15	0.58	15	0.71	15	0.92	15	0.64	15	1.08	14	12.46
Thayne	6.8	7	1.70	7	1.54	8	1.74	8	1.27	8	2.63	7	1.06	6	0.86	7	0.88	7	0.77	6	1.29	5	1.07	6	1.14	4	15.95
Region	9.3	10	1.36	9	1.41	9	1.46	10	1.28	10	1.75	9	1.05	9	0.77	10	0.77	9	1.14	9	1.23	9	0.88	10	1.08	7.6	14.27

TABLE 3. AVERAGE NUMBER OF DAYS WITH .01 INCH OR MORE OF PRECIPITATION

Station	Av. length of available record years	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Annual	
		yrs	days	yrs	days	yrs	days	yrs	days	yrs	days	yrs	days	yrs	days	yrs	days	yrs	days	yrs	days	yrs	days	yrs	days	Years complete	days
Afton	14.8	14	8	15	9	16	11	16	8	15	11	14	7	15	5	15	5	15	6	15	7	14	6	14	8	11	91
Bedford	19.9	20	10	20	9	19	10	20	8	20	10	20	7	20	5	20	5	20	6	20	7	20	6	20	8	18	91
Blackfoot Dam	4.8	5	8	4	9	4	6	5	5	5	8	5	3	5	5	5	2	4	5	5	4	5	5	5	6	3	66
Border	17.9	18	7	18	8	18	6	18	6	18	7	17	6	18	6	18	6	18	7	18	7	18	6	18	7	15	79
Chesterfield	3.2	4	8	3	7	4	7	4	7	3	10	3	4	4	6	3	2	3	5	3	2	2	7	2	8	0	73
Cokeville	9.4	10	8	10	8	9	7	9	6	10	8	10	5	9	6	9	3	9	3	9	6	9	6	10	5	7	71
Fort Hall	4.9	4	7	5	8	5	8	5	7	5	8	5	4	5	6	5	4	5	6	5	5	5	6	5	7	4	76
Geneva	1.9	2	6	2	8	2	7	2	4	2	7	2	6	2	4	2	4	1	6	2	4	2	5	2	5	1	66
Grace	4.0	5	8	4	8	5	6	5	5	4	7	3	2	5	4	4	4	4	6	4	6	3	6	2	9	1	71
Grays Lake	1.7	3	5	2	6	2	4	1	3	..	..	3	3	2	3	2	4	1	7	..	..	2	4	2	6	0	..
Idaho Falls	8.7	8	10	8	7	9	8	9	6	9	11	9	6	9	5	9	6	9	5	9	6	8	5	8	7	7	82
Montpelier	4.8	5	10	5	10	5	8	5	8	5	9	4	3	5	4	5	2	5	6	5	7	4	7	4	6	3	80
Paris	13.0	13	9	13	7	13	8	13	6	13	7	13	5	13	3	13	4	13	4	13	5	13	6	13	8	13	72
Pocatello	14.0	14	11	14	10	14	11	14	9	14	10	14	6	14	5	14	6	14	4	14	6	14	7	14	10	14	95
Thayne	7.0	7	12	7	12	7	14	7	10	7	12	7	7	7	8	7	5	7	5	7	8	7	10	7	10	7	113
Region	8.7	9	9	9	8	9	9	9	7	9	9	9	6	9	5	9	5	9	5	9	6	8	6	8	8	6.9	84

TABLE 4. AVERAGE SNOWFALL (UNMELTED: INCHES)

Station	Av. length of available record years	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Annual	
		yrs	in.	yrs	in.	yrs	in.	yrs	in.	yrs	in.	yrs	in.	yrs	in.	yrs	in.	yrs	in.	yrs	in.	yrs	in.	yrs	in.	Years complete	in.
Afton	14.8	14	17.0	16	16.5	16	12.6	16	7.6	14	3.2	13	1.7	15	0	16	0	15	1.1	14	4.7	14	5.9	14	11.7	11	82.0
Bedford	19.9	20	21.2	20	23.9	19	14.3	20	6.5	20	3.3	20	0.4	20	0	20	0	20	0.9	20	5.2	20	8.8	20	15.1	19	99.6
Blackfoot Dam	4.5	4	15.8	4	19.5	3	13.5	5	2.0	5	2.5	5	T	5	0	5	0	4	0.1	4	4.9	5	8.6	5	14.2	1	81.1
Border	13.4	14	16.7	13	14.6	12	18.6	13	6.3	13	2.1	14	T	14	T	14	0	15	1.4	13	2.4	13	4.6	13	4.6	11	71.3
Chesterfield	3.3	4	14.5	4	18.8	4	5.2	4	1.5	3	0.3	4	T	4	0	3	0	3	T	3	T	2	6.0	2	12.6	0	58.9
Cokeville	9.5	10	13.8	10	13.9	9	9.8	9	6.3	9	2.2	10	0.4	9	0	9	0	10	1.5	10	5.2	9	7.1	10	8.1	8	68.3
Fort Hall	5.0	5	4.3	5	8.3	5	6.4	5	0.8	5	0.2	5	T	5	0	5	0	5	0	5	0.6	5	2.0	5	5.5	5	28.1
Geneva	1.9	2	19.5	2	15.0	2	6.5	2	2.5	2	7.0	2	2.5	2	0	2	0	1	0	2	0.5	2	10.5	2	12.0	1	76.0
Grace	3.8	4	5.4	4	9.4	4	5.0	5	1.7	3	0.5	3	0.2	5	0	4	0	4	0	4	1.0	3	3.2	2	6.2	1	32.6
Grays Lake	2.8	3	20.5	2	22.0	2	17.0	1	4.0	2	1.8	3	T	3	0	2	0	1	0	..	...	2	8.8	3	14.2	0	....
Idaho Falls	4.4	3	10.3	3	9.6	4	2.4	5	0.8	5	0.6	5	0	5	0	5	0	5	T	5	2.3	4	2.4	4	7.2	2	35.6
Montpelier	4.7	5	17.0	5	24.4	4	4.0	5	5.0	5	1.9	4	1.6	5	0	5	0	5	T	5	4.1	4	9.1	4	6.8	2	73.9
Pocatello	5.0	5	12.7	5	13.1	5	8.1	5	3.0	5	0.1	5	T	5	0	5	0	5	T	5	0.8	5	2.5	5	9.6	5	49.9
Thayne	7.0	7	15.0	7	12.3	7	10.4	7	4.5	7	3.4	7	T	7	0	7	0	7	1.5	7	2.6	7	5.5	7	10.3	7	65.5
Region	7.1	7	15.8	7	15.8	7	11.3	7	4.9	7	2.3	7	0.5	7	T	7	0	7	0.8	7	3.5	7	6.2	7	10.3	5	70.8

TABLE 5. HIGHEST TEMPERATURE—MONTHLY AND ANNUAL

Station	Av. length of available record: years	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		The Period	
		yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	Years Complete	Degrees
Afton	14.9	16	70	16	55	16	69	16	81	15	86	14	92	15	96	14	94	14	91	15	82	13	76	15	59	13	96
Bedford	19.9	20	49	20	58	20	59	20	76	20	93	20	93	20	97	20	93	20	88	19	82	20	66	20	51	19	97
Blackfoot Dam	4.7	5	50	5	47	4	57	5	80	5	78	5	94	5	96	5	94	4	89	4	78	4	64	5	55	4	96
Border	17.9	18	48	18	50	18	67	18	79	18	88	17	94	18	96	18	96	18	88	18	84	18	67	18	58	17	96
Chesterfield	3.5	4	56	5	45	5	64	4	78	3	76	4	94	4	94	3	95	3	89	2	77	2	72	3	54	1	95
Cokeville	9.9	10	53	10	63	10	64	10	79	10	90	10	96	9	96	10	93	10	89	10	75	10	64	10	51	9	96
Fort Hall	5.0	5	57	5	52	5	69	5	81	5	94	5	100	5	98	5	100	5	91	5	83	5	70	5	58	5	100
Grace	4.8	5	68	4	50	5	70	5	84	5	95	4	100	5	103	5	101	5	98	5	90	5	69	4	63	4	103
Grays Lake	2.3	3	48	2	44	3	62	2	62	2	77	3	94	3	103	2	90	1	88	1	75	2	66	3	54	0	103
Idaho Falls	9.0	9	51	9	57	9	68	9	81	9	95	9	98	9	98	9	97	9	90	9	82	9	70	9	58	9	98
Montpelier	4.9	5	52	5	51	5	61	5	76	5	92	5	98	5	100	5	100	5	89	5	79	5	67	4	53	4	100
Paris	15.0	15	61	15	63	15	64	15	79	15	88	15	97	15	97	15	97	15	92	15	87	15	78	15	59	15	97
Pocatello	14.0	14	57	14	56	14	68	14	80	14	94	14	99	14	102	14	99	14	92	14	82	14	69	14	57	14	102
Thayne	7.0	7	47	7	55	7	56	7	74	7	81	7	92	7	96	7	91	7	87	7	78	7	65	7	48	7	96
Region mean	....	..	55.1	..	55.3	..	64.6	..	78.7	..	89.2	..	95.4	..	97.6	..	95.6	..	90.0	..	82.1	..	69.3	..	55.6	..	97.6
absolute	9.5	10	70	10	63	10	70	10	84	10	95	9	100	10	103	9	101	9	98	9	90	9	78	9	63	8.6	103

TABLE 6. LOWEST TEMPERATURE—MONTHLY AND ANNUAL

Station	Av. length of available record years	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		The Period	
		yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	Years Complete	Degrees
Afton	15.1	16	-47	16	-41	16	-23	16	- 5	15	4	14	22	15	18	14	16	15	15	15	- 2	13	-26	15	-44	13	-47
Bedford	19.9	20	-34	20	-46	20	-27	20	- 6	20	13	20	20	20	24	20	22	20	16	19	3	20	-26	20	-30	19	-46
Blackfoot Dam	4.9	5	-35	5	-38	4	-27	5	- 7	5	13	5	22	5	31	5	28	5	17	5	- 4	5	-25	5	-42	4	-42
Border	17.9	18	-37	18	-48	18	-36	18	- 1	18	12	17	19	18	27	18	20	18	13	18	-18	18	-29	18	-36	17	-48
Chesterfield	3.5	4	-38	5	-29	4	-25	4	- 5	3	4	4	25	4	26	3	21	3	12	2	9	3	-16	3	-29	2	-38
Cokeville	9.9	10	-38	10	-44	10	-38	10	- 6	10	8	10	18	9	26	10	21	10	13	10	-12	10	-20	10	-33	9	-44
Fort Hall	4.9	5	-26	5	-13	4	8	5	13	5	17	5	27	5	34	5	33	5	24	5	4	5	-12	5	-28	4	-28
Grace	4.6	5	-22	4	-12	5	-14	5	6	5	21	4	29	5	32	5	32	5	25	4	10	4	- 7	4	-23	2	-23
Grays Lake	2.3	3	-42	3	-21	3	-31	2	- 3	2	12	3	25	3	25	2	29	1	25	1	- 8	2	- 8	3	-40	1	-42
Idaho Falls	9.0	9	-31	9	-32	9	-26	9	13	9	20	9	28	9	36	9	31	9	23	9	1	9	-11	9	-23	9	-32
Montpelier	5.0	5	-32	5	-24	5	-25	5	0	5	13	5	23	5	24	5	30	5	17	5	0	5	-20	5	-26	5	-32
Paris	15.0	15	-33	15	-35	15	-23	15	0	15	15	15	15	15	21	15	24	15	15	15	3	15	-13	15	-19	15	-35
Pocatello	14.0	14	-19	14	-20	14	-12	14	17	14	24	14	33	14	38	14	33	14	21	14	3	14	- 3	14	-13	14	-20
Thayne	7.0	7	-26	7	-47	7	-23	7	2	7	11	7	21	7	24	7	19	7	13	7	7	7	- 1	7	-30	7	-47
Region mean	....	..	-33.5	..	-36.3	..	-24.7	..	1.0	..	13.5	..	22.3	..	26.8	..	25.2	..	16.7	..	- 0.7	..	-17.7	..	-29.3	..	-40.4
absolute	9.5	10	-47	10	-48	10	-38	10	- 7	10	4	9	15	10	18	9	16	9	12	9	-18	9	-29	10	-44	8.6	-48.0

TABLE 7. MEAN TEMPERATURES—MONTHLY AND ANNUAL

Station	Av. length of available record: years (from monthly records)	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Annual	
		yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	yrs	deg.	Years Complete	Degrees
Afton	14.0	15	16.4	15	18.9	15	27.5	15	35.7	14	46.9	13	55.7	14	61.0	13	60.0	14	52.6	14	43.8	12	32.8	14	18.0	12	39.2
Bedford	19.8	20	17.4	20	19.6	19	27.9	20	37.2	20	46.1	20	53.2	20	59.8	20	58.6	20	50.9	19	41.2	20	30.2	20	17.5	18	38.2
Blackfoot Dam	4.7	5	14.4	5	18.1	4	25.3	5	37.7	5	46.7	5	56.6	5	62.9	5	58.2	4	51.2	4	41.4	4	27.5	5	16.9	4	37.8
Border	19.9	20	12.8	20	14.6	20	25.1	20	38.7	20	47.2	19	56.0	20	63.1	20	60.9	20	51.6	20	40.9	20	28.5	20	13.9	20	37.8
Chesterfield	3.3	3	19.1	5	20.8	4	28.2	4	41.0	3	45.3	4	54.7	4	61.9	3	60.0	3	51.2	2	42.2	2	32.4	3	23.9	..	....
Cokeville	9.8	10	15.5	10	18.4	10	27.5	10	38.2	10	46.3	10	55.3	9	61.1	9	58.3	10	49.9	10	37.6	10	26.7	10	14.9	9	37.7
Fort Hall	4.8	5	20.2	4	29.4	4	39.1	5	45.6	5	51.2	5	61.7	5	69.6	5	66.9	5	58.6	5	45.7	5	33.3	5	25.3	4	45.4
Grace	4.7	5	21.7	4	27.0	5	34.0	5	44.7	5	51.0	4	61.6	5	69.8	5	66.8	5	59.7	4	46.0	4	32.1	5	26.6	2	45.2
Grays Lake	1.4	3	14.0	2	19.0	3	24.9	2	34.3	2	42.3	3	55.0	3	61.7	2	58.9	1	52.9	1	39.4	2	31.8	3	30.7	..	....
Idaho Falls	19.0	19	18.3	19	22.1	19	32.4	19	44.4	19	51.5	19	59.3	19	68.0	19	67.1	19	57.7	19	45.0	19	31.7	19	22.5	19	43.3
Montpelier	4.8	5	16.3	5	21.0	5	28.0	5	41.2	5	47.9	5	59.1	5	66.0	5	63.7	5	54.8	5	42.3	4	31.4	4	22.6	4	41.4
Paris	15.0	15	19.7	15	19.7	15	27.4	15	39.6	15	49.2	15	55.8	15	63.5	15	62.9	15	55.0	15	44.0	15	33.1	15	21.0	15	40.9
Pocatello	19.0	14	24.6	14	28.9	14	38.7	14	46.7	14	54.3	14	64.0	14	71.5	14	70.3	14	60.8	14	48.2	14	36.2	14	28.3	14	47.6
Thayne	7.0	7	18.7	7	18.9	7	28.0	7	37.7	7	47.5	7	54.3	7	60.3	7	58.7	7	50.1	7	40.9	7	31.9	7	18.3	7	38.8
Region	10.5	10	17.7	10	21.2	10	29.4	10	40.2	10	48.6	10	57.1	10	64.1	10	61.9	10	54.1	10	43.0	10	31.3	10	20.1	10.7	40.8

TABLE 8. PREVAILING WIND DIRECTION

Station	Av. length of available record: years (from monthly record)	Jan.		Feb.		Mar.		Apr.		May		June		July		Aug.		Sept.		Oct.		Nov.		Dec.		Annual	
		yrs	wind	yrs	wind	yrs	wind	yrs	wind	yrs	wind	yrs	wind	yrs	wind	yrs	wind	yrs	wind	yrs	wind	yrs	wind	yrs	wind	Years Complete	Wind
Afton	4.1	5	N	5	W	5	S	5	SW	4	S	3	S	4	SW	3	S	4	S	4	S	3	S	4	S	4	S
Bedford	19.9	20	W	20	W	20	W	20	W	20	W	20	W	20	W	20	W	20	W	19	W	20	W	20	W	20	W
Blackfoot Dam	4.9	5	SW	5	SW	4	SW	5	SW	5	SW	5	SW	5	SW	5	SW	5	SW	5	SW	5	SW	4	SW	5	SW
Border	16.9	17	W	17	W	17	W	17	W	18	W	17	W	17	W	18	W	16	W	16	W	17	W	16	W	17	W
Chesterfield	2.1	1	S	2	SW	3	W	2	W	3	W	3	W	2	W	2	W	2	W	2	W	2	W	1	S	2	W
Cokeville	9.4	10	W	10	W	10	W	9	W	10	W	10	W	9	W	9	W	10	W	9	W	8	NW	9	W	10	W
Fort Hall	4.3	5	SW	5	SW	5	SW	5	SW	4	SW	5	SW	3	SW	5	SW	3	SW	4	SW	3	SW	4	SW	5	SW
Grace	2.3	3	S	2	S	1	S	2	NW	1	W	3	S	3	W	3	W	2	S	3	SW	1	N	3	S	2	S
Grays Lake	1.6	3	SW	1	SW	3	SW	2	SW	..	....	3	SW	3	SW	1	SW	..	....	..	....	1	SW	2	SW	1	SW
Idaho Falls	7.1	8	NE	8	NE	8	NE	8	NE	8	NE	6	NE	7	NE	7	NE	7	NE	5	NE	6	NE	7	NE	6	NE
Montpelier	2.1	3	N	3	S	2	N	3	N	2	W	2	NW	2	S	2	N	2	NW	2	N	1	N	1	N	2	N
Paris	15.0	15	NW	15	NW	15	W	15	W	15	W	15	W	15	W	15	NW	15	NW	15	NW	15	W	15	W	15	W
Pocatello	14.0	14	SE	19	SE	14	SE	14	SE	14	SW	14	SE	14	SE	14	SE	14	SE	14	SE	14	SE	14	SE	14	SE
Thayne	7.0	7	SE	7	SE	7	SE	7	SE	7	SW	7	W	7	W	7	SW	7	W	7	W	7	SE	7	SE	7	SE
Region	7.2	8	W	8	SW	8	W	8	W	9	W	8	W	8	W	8	W	8	W	8	W	7	W	8	W	7.9	W

TABLE 9. FROST DATA

Station	Length of Available Record: Years	Average Date of First Killing Frost in Autumn		Average Date of Last Killing Frost in Spring		Earliest Date of Killing Frost in Autumn		Latest Date of Killing Frost in Spring		Length of Growing Season: Average Number of Days Between Last and First Killing Frost	
		Yrs.	Date	Yrs.	Date	Yrs.	Date	Yrs.	Date	Yrs. Complete	Days
Afton	13	10	Aug. 23	10	June 14	13	Freezing temp. every month	12	Freezing temp. every month	8	61
Bedford	19	15	Aug. 25	15	June 27	19	Freezing temp. or lower every month	19	Freezing temp. or lower every month	18	60
Blackfoot Dam	4	4	Aug. 29	4	June 11	4	Aug. 14	4	June 23	4	78
Border	17	13	Aug. 27	13	June 22	17	Freezing temp. or lower every month	17	Freezing temp. or lower every month	14	61
Chesterfield	4	4	Aug. 15	4	June 25	4	July 1	4	June 30	4	50
Cokeville	9	5	Aug. 18	5	June 5	9	Freezing temp. every month	9	Freezing temp. every month	8	69
Fort Hall	4	4	Sep. 26	4	May 27	4	Sep. 10	4	June 13	4	122
Geneva	4	4	Sep. 4	4	July 6	4	Aug. 22	4	July 19	4	59
Grace	4	4	Sep. 23	3	May 29	4	Sep. 9	3	June 13	3	116
Grays Lake	2	..	.....	..	.....	1	Sep. 14	2	June 30	1	93
Idaho Falls	8	4	Sep. 12	4	May 22	8	Aug. 31	8	June 20	8	122
Montpelier	3	3	Sep. 6	3	June 7	3	Aug. 22	3	June 30	3	90
Paris	13	13	Sep. 3	13	June 14	13	Aug. 9	13	June 28	13	80
Pocatello	13	9	Oct. 12	9	Apr. 20	13	Sep. 14	13	May 15	13	167
Pocatello Nursery	3	3	Sep. 26	3	June 19	3	Sep. 10	3	June 26	3	98
Thayne	6	6	Sep. 1	6	June 28	6	Aug. 18	6	July 9	6	63
Region	8.4	7	Sep. 4	7	June 10	8	Freezing temp. every month	8	Freezing temp. every month	7	86

for each station for each month and for the year. Table 8 shows the prevailing wind direction, and Table 9 gives frost data and shows the length of the growing season at each station and for the region.

In all these tables, where monthly records are given, a parallel column for each month shows the number of years for which the record of that month is available at the given station. From these parallel columns the average length of the available record in years, shown in another column, is computed. This column is used for computing the annual means, but another column is added to show the number of complete years for which the record at any station is available. In the regional summary included in most of the tables the averages are weighted according to the lengths of the records at the respective stations.

RAINFALL.—The climate of the region is semi-arid with an annual rainfall for the stations named ranging from 9.57 inches (Fort Hall) to 18.59 inches (Afton). The average for the region as determined by the given records is 14.27 inches. In the mountains the quantity is doubtless somewhat greater but no stations have thus far been maintained in the actual mountains. Table 2 shows the distribution of the precipitation throughout the year.

The maximum mean monthly rainfall for the region, as shown in Fig. 2, A, is 1.75 inches and occurs in May, but at Blackfoot Dam and Montpelier the maximum occurs in February; at Idaho Falls, Paris, and Pocatello it is in March; and at Border and Cokeville it is in April. At some stations, such as Blackfoot Dam and Montpelier, the length of the record is so short that the time of occurrence of the maximum may have been unduly affected by a few severe storms. At other stations, such as Idaho Falls and Pocatello, where the record is longer, it is probable that local conditions affect the time of occurrence of the maximum so that it is habitually earlier than that for the region. Lesser maxima occur in March (1.46 inches) and in October (1.23 inches).

The minimum rainfall for the year occurs in July and August, for each of which months the mean annual amount is .77 inches. This occurs chiefly during thunder showers. Secondary minima occur in November, with a mean of .88 inches, and in April, with a mean of 1.26 inches. Thus precipitation throughout the year is well distributed but is marked by fairly systematic fluctuations.

Thayne has the largest number of rainy days (113, see Table 3) but both Bedford and Afton have more precipitation, probably because they are situated nearer the windward base of high mountains. The lowest recorded number of rainy days for the year in the region is 66, at Geneva and at Blackfoot Dam. The records at both of these stations

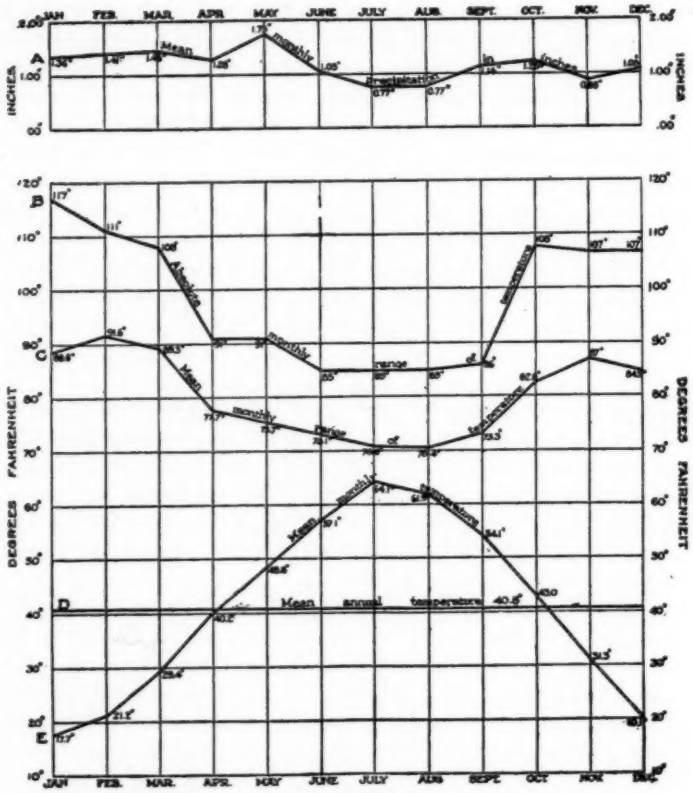

FIG. 2.—Graphic summary of precipitation and temperature data

are so short that they do not afford a satisfactory average. Probably observations for longer periods would show higher results, for the average for the region is 84 rainy days per year.

The snowfall for the region, Table 4, is fairly heavy, the mean annual amount being 70.8 inches or nearly 6 feet, unmelted. The maximum monthly average is 15.8 inches, which is the amount occurring both in January and in February. Snowfall is recorded at most of the stations in all months except July and August and at Border a trace of snow is even recorded in July. The heaviest annual snowfall is reported at Bedford, 99.6 inches, and at Afton, 82.0 inches. Both these stations lie at the windward base of the Salt River Range, which a few miles eastward reaches altitudes greater than 10,000 feet. The largest average amount recorded for any month at any station is 24.4 inches for February at Montpelier. The record for this station covers

so short a period that it has doubtless been unduly affected by severe storms. In the mountains the snowfall is without doubt heavier than at the stations which furnish the available records, a fact attested by the frequency of snowslides in the canyons, some of which have caused loss of life and property.

TEMPERATURES.—Southern Idaho lies outside the usual tracks of storms, so that both storms and cold waves are relatively infrequent and the temperature as a whole is equable. In southeastern Idaho, however, the valleys are higher than they are farther west and are bordered by fairly high mountains. Thus, extremes of temperature are somewhat more marked in that region. Local topographic conditions exert a marked control upon the climate in different parts of the district.

Table 5 shows the highest recorded temperatures of each station for each month and for the period, and also the mean of the highest temperatures and the absolute highest temperature for each month and for the period for the region. Table 6 gives similar data for the lowest temperatures. July has the hottest days at all but two of the stations, the absolute maximum or the actual highest recorded temperature being 103 degrees, indicated at two stations, namely, Grace and Grays Lake. The mean of the highest temperatures for the same month for the region is only a few degrees lower, 97.6. The lowest temperatures at a majority of the stations, including all but one of those with the longer records, are in February, the absolute minimum being 48 degrees below zero, recorded at Border. The mean of the minima for the same month is —36.3 degrees. The mean of the minima for the region is —40.4 degrees. Afton, Bedford, Cokeville, Grays Lake, and Thayne all have recorded minima lower than 40 degrees below zero.

The difference between the absolute maximum and the absolute minimum temperature for a given month is the absolute range of temperature for that month. Similarly the difference between the mean of the highest temperatures and the mean of the lowest temperatures for a given month is the mean range of temperature for that month. Figure 2, B and C, shows the absolute monthly and mean monthly ranges of temperature for the region. The absolute range is greatest in January, 117 degrees. It diminishes gradually to March (108°), more abruptly to April and May (each 91°) and again gradually to June, the minimum, (85°). The absolute range continues practically uniform from June through September but in October it increases rapidly to 108°, again remaining nearly uniform for the remainder of the year. The mean monthly range is also greater in the months from October to March, the two maxima being in February (91.6°) and in October (87°). From March (89.5°) to April (77.7°)

the decrease is rather abrupt as in the case of the absolute monthly mean. From April to July, however, the decrease is more gradual. For July and August the mean monthly range is nearly the same but the figure for August, which is also the minimum (70.4) is slightly lower. For September the mean monthly range is somewhat higher but there is a sharp increase in October, as in the case of the absolute monthly range.

A noteworthy feature is the mean of the lowest temperatures for the summer months. This bears witness to the coolness of the summer nights and shows the danger of frost incurred by crops growing on bottom lands, where cool air may stagnate.

The extreme temperatures noted above fortunately do not long persist for the mean temperature of the warmest month for the region is only 64.1° (July), see Table 7, and that for the coldest month is 17.7° (January). The stations recording the highest mean temperatures for the warmest and coldest months are respectively Pocatello 71.5° (July) and Border 12.8° (January). The mean annual temperature for the region is 40.8°. The mean monthly temperature curve for the region, see Fig. 2 D and E, is fairly uniform, rising gradually from January (17.7°) to February (21.2°) and then more rapidly at a nearly even rate to July (64.1°). The fall from July to August (61.9°) is rather gentle but from August to December (20.1°) it is more rapid and again nearly even.

It is probable that Bear Lake exerts a modifying influence upon the temperature of territory adjacent to it but the arrangement and records of the stations are not such as to make this influence clearly evident. The effects of difference in altitude upon the annual mean temperature are perhaps shown in a general way since the stations with the higher means have on the whole lower altitudes than those with lower means. This effect, however, is overshadowed to some extent by local conditions. Thus Grace, which is 900 feet higher than Fort Hall has nearly the same mean annual temperature. It is possible that Pocatello, which has the highest mean annual temperature of all the stations, 47.6°, may owe its excess of temperature in part to the warming, by compression, of the cool air that descends from neighboring uplands into the relatively narrow valley of Portneuf River.

Winds.—The prevailing winds, see Table 8, are westerly and ordinarily not of great velocity except on the more exposed slopes and at higher altitudes. Local conditions again play an important part in the control of wind direction. Thus stations like Fort Hall, which permit a practically unrestricted sweep for the wind, have westerly winds the year round. Other stations like Pocatello and Idaho Falls, situated in more or less restricted valleys have their wind direction

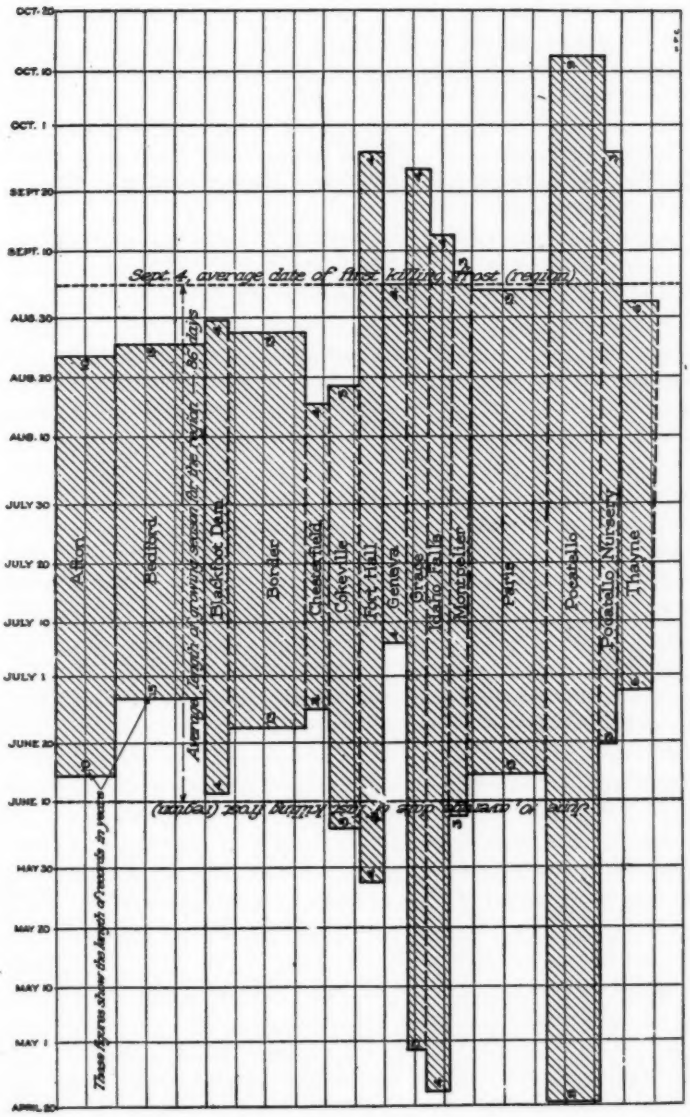

FIG. 4.—First and last killing frost and length of the growing season at fifteen stations in Southwestern Idaho and Western Wyoming

modified by these valleys. Thunder storms are of frequent occurrence in July and August but they often clear away over the broader valleys and yield little rain except in the higher hills. Convectional whirls bearing clouds of dust and light objects, such as bits of grass and sage brush, occur in some of the broader and drier valleys.

Frosts and the Growing Season.—In a general discussion of frost conditions throughout the United States Reed[3] presents a series of maps from which data bearing upon southeastern Idaho may be gathered.

The season of security from destructive frosts at the stations named, as compiled from the other reports previously cited, is shown in Table 9. At many stations, see also Table 6, freezing temperatures have been reported for every month in the year. In general, however, a growing season ranging in length from 50 days (Chesterfield) to 167 days (Pocatello) and averaging 86 days for the region may be expected. It is probable that the lowest figure is unduly small because of the brevity of the available record. The length of the growing season at a given station as compared with that at other stations is shown graphically in Fig. 3.

The stations with the longer growing seasons are in general lower than those where the season is shorter but, as in the distribution of mean temperature, local physiographic conditions play an important part. Pocatello Nursery, which is nearly 1,000 feet higher than Pocatello, has a much shorter growing season than that station. This difference is doubtless due in part to the greater altitude, but the former station may also lack other physiographic advantages enjoyed by the latter (see page 90). Comparison of Tables 9 and 7 shows the close correspondence of length of growing season and mean temperature at the respective stations. Thus Pocatello, Idaho Falls, Grace, and Fort Hall, which have the longer growing seasons, have also the higher mean temperatures. For much of the region a growing season of more than 60 days may reasonably be expected but the time may be extended if physiographic conditions warrant. Thus the bottom lands, as previously noted, are subject to frost and are therefore not adapted to any but the hardiest crops. They are largely given over to the production of wild hay. On the other hand along the sides of the valleys, on slightly higher ground, the cold air does not linger, and valuable crops, such as wheat, oats, rye, alfalfa, hay, and potatoes, may be raised. In the larger valleys considerable areas are suitable for irrigation but the practice of dry farming is increasing and all the larger soil areas whether irrigable or not, are being rapidly taken up for cultivation.

[3] Reed, W. G., Frost and the growing season; U. S. Dept. Agr., Office of Farm Management, Atlas of American Agriculture, Part 2, Climate, 1918, Washington.

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MEMOIR OF ROBERT EDWIN PEARY

WILLIAM HERBERT HOBBS

The attainment of the earth's northern geographic pole, for nearly four centuries the great goal of exploration, was an achievement surpassing all others in general interest and one which aroused the patriotic pride of the American people in no small degree. That the sturdy American who succeeded after devoting a life-time to the attainment of this goal should, through no fault of his own, have been defrauded of his immediate reward in the acclaim of his country and made the object of vicious attack through the greatest scientific hoax which history records, is one of the outstanding tragedies of polar exploration.

Throughout Europe with the exception of Denmark, the strident claims of the imposter produced little reaction, but with a license which is nothing if not American the already discredited claimant for polar honors in the rôle of a vaudeville performer sought to signalize every appearance of Peary for a public address by his own presence in the same vicinity where, from the local stage and often through the local press, he launched his torrent of abuse with such vigor as to supply all needed advertisement for his own further appearances. Only when the great explorer was stricken down by the illness which led up to his death did this profitable career of infamy come to an end,—whereupon this experienced fakir deserted the stage for other now more profitable fields.

If the attainment of the northern pole bulks largest in the popular mind among the achievements of Admiral Peary, in the estimation of geographers it hardly surpasses those other discoveries mainly upon the Greenland continent which will always be connected with his name. It was his merit to have introduced into the exploration of the polar regions new and improved methods of attack which have transformed both the strategy and the tactics of polar campaigns. It was the "Peary System" of supporting parties which eventually conquered both the northern and the southern pole, though the methods were different in the two regions. It was his discovery of the advantages of the "Imperial Highway" across the inland-ice which, followed not only by Peary himself, but by Nansen, de Quervain, Koch and Wegener, and by Rasmussen, has made known to the world the vast interior of the Greenland continent.

Before Peary's methods were adopted it was apparently the rather general opinion of Arctic explorers that journeys in the winter season were impracticable by reason of the extreme cold, and Sir George Nares is quoted as saying that any officer should be censured if he exposed

his men to the hardships of winter travel. Peary conquered the cold by the adoption of suitable fur clothing, and he carried out his successful polar campaign in the latter part of the winter season, arriving at the Pole on the 6th of April. It is, in fact, doubtful if it could have been reached over the ice in the summer season.

It was Peary's great discovery also that above the inland-ice all strong surface air currents blow down the slope. This observation made it obvious that continental glaciers have an auto-circulation and make their own weather, instead of having it brought to them by the migrating whirls of the atmosphere.

It is perhaps well to point out that the hazard involved in exploration within the North Polar region is very much greater than that in the region surrounding the opposite pole. The former is a frozen sea traversed by a network of hummocky ice ridges and of lanes of open water. Both these networks shift their position and change their pattern without warning, at the caprice of the winds. As well might one expect to recover a depot of supplies set adrift upon a raft in the open sea, as to recover anything which has been cached upon the ice of the Arctic Sea. On the contrary, the surface of the South Polar region is almost as stable as *terra firma,* and the explorer is assured that his back trail will remain where he left it.

The more important events of Peary's life may be set down in order. Born in Cresson, Pennsylvania, on May 6, 1856, he studied at Bowdoin College, where he distinguished himself both in scholarship and in athletics, and where he received its degree of Civil Engineer in 1877. After a term of service as draftsman in the U. S. Coast and Geodetic Survey, he entered the United States Navy as civil engineer in 1881, and in 1884-85 was assistant engineer on the surveys for a Nicaraguan Ship Canal, and engineer-in-charge in the period from 1887 to 1888.

Peary's polar work had, however, been started in 1886 when he carried out a reconnaissance upon the inland-ice of Greenland to the eastward of Disco Bay. This trip was undertaken with one companion, the Danish officer, Maigaard, and Peary succeeded in ascending one of the outlets of the inland-ice and in going due eastward until he had reached a point nearly one hundred miles from the margin and at an elevation of 7,500 feet. He supplied a better picture of the essential conditions and seasonal variations within the marginal area of the inland-ice than had before been set forth, and his reconnaissance was of prime importance in proving to him the entire feasibility of travel across the continent, once the height of the plateau has been reached. This journey thus paved the way for the epoch-making sledge journeys which he carried out later in northern Greenland. Writing in 1887 of a small party equipped according to his then method, he declared confidently, " the deep, dry, unchanging snow of the interior is not a *bête*

noir, but something to be reached, as noted above, at the earliest possible moment, and once reached, it is an imperial highway, over which a direct course can be taken to the east coast." He appears at this time not to have known that Baron Nordenskiöld had already in 1870 and again a few years before, carried out a somewhat similar journey from near the same base, for he wrote in 1898, " For the first time the deep, unchanging, incoherent snow of the central plateau was reached. . . ."

The North Greenland Expedition of 1891-92 was undertaken to test out the methods learned from the reconnaissance of 1886, and despite the fact that shortly after reaching Greenland with this expedition Peary had been struck by the iron tiller of his ship and had both bones of his right leg broken above the ankle, he none the less succeeded in carrying out the purpose of his expedition and established a record for long distance dog sledging without a cache from beginning to end in a thirteen hundred mile journey. On this expedition he discovered an arm of the East Greenland Sea to the eastward of the Greenland continent and christened it Independence Bay. The success achieved in this expedition was in no small measure to be ascribed to the adoption of suitable clothing. Of this fur clothing of Eskimo pattern, he declared: " I could keep perfectly warm and yet not get into a perspiration in temperatures from +40° F. to —50° F. whether at rest, or walking, or pulling upon a sledge." No tent was carried and no sleeping bags, the fur clothing affording ample protection both day and night.

This expedition for the first time made probable, though it did not prove, the insularity of Greenland; it showed the nature of the surface of the inland-ice throughout a wide zone, the outward circulation of air above its surface, and the rough delimitation of almost the entire northwest coast of Greenland. In addition detailed maps were prepared of Inglefield Gulf and of Whale and Murchison Sounds.

Peary's statement concerning the outward air circulation above the inland-ice, as made to the Royal Geographical Society, may well be cited here, since it represents the first clear exposition of a fact now well established:

" There is one thing of special interest to the glacialist—the transportation of snow on the ice-cap by the wind. No one who has not been there can have any conception of its magnitude. The wind is always blowing, and blowing always on lines which would be gravity lines from the interior. The regularity of the winds of the ' Great Ice ' of Greeland, as I have found them during an actual sojourn of over seven months upon the ice-cap and visits to it of greater or less duration in every month of the year, is phenomenal. Except during atmospheric disturbances of exceptional magnitude, which cause storms to sweep across the country against all ordinary rules, the direction of the wind

of the 'Great Ice' of Greenland, is invariably radial from the center outward, normal to the nearest part of the coast-land ribbon. So steady is this wind, and so closely does it adhere to this normal course, that I can liken it only to the flow of a sheet of water descending the slopes from the central interior to the coast."

No sooner had Peary returned from the expedition of 1891-92 than he set himself to work to secure the funds and the necessary outfit for a second expedition to the same region. As a consequence he found no time to set forth the scientific results of the last one and Dr. Cyrus C. Adams, then of the American Geographical Society, making use of Peary's material, with his permission, presented a very valuable summary in the *Geographical Journal*.

The expedition of 1893-95 was carried out under the auspices of the Geographical Club of Philadelphia, later to become the Geographical Society of Philadelphia. This expedition resulted in a new transection of northern Greenland and the discovery of the three Cape York meteoric irons, one of them the largest known to exist.

A disaster which would have disheartened almost any explorer befell the expedition. A depot which had been established upon the inland-ice in preparation for the long journey and which contained almost the entire supply of provisions (nearly a ton and a half), was buried and lost beneath the drift-snow of a terrific blizzard which continued throughout six days and nights. After diligent but futile search for the buried cache, Peary felt himself in the position of a man shipwrecked, and he wrote,

> "What should I, what could I do? and yet the idea of abandoning the journey never for a moment occurred to me, nor I think to either of my companions. It would be necessary to revert to first principles, revise our programme, and then trust to the Almighty. . . . As it was, my favorite nightmare during the winter was to dream that I was back home again without having been able to make another attack upon the ice-cap and I would waken with a feeling of positive relief to find myself stretched on my bearskin with the howling wind of the great night tearing at the house, and to realize that I still had the struggle before me. That I had reason for this fear will be understood from our utter lack of any margin for accidents or mishaps, either to ourselves, our material, or our supplies."

Peary's companions, Lee and Henson, were indeed for a considerable period incapacitated, the former because of exhaustion after an arduous surveying trip, and the latter from the grippe. Peary himself in lashing down a sledge in the midst of a storm was nearly brained by a heavy box of frozen meat which was blown from the roof of the hut and which, grazing his temple, rendered him arm useless for a week. Again, on a trip to Cape York in the midst of the Arctic night Peary narrowly escaped being engulfed with his team when a big berg capsized and smashed the ice about him.

In the first attempt to cross the inland-ice during the season of 1894, Peary's party encountered a blizzard at that time unprecedented for severity in the annals of Arctic work and several of his dogs were frozen as they slept, though the members of the party in their fur clothing suffered only frozen fingers and toes. For thirty-four hours the average air temperature was —50° F. and the wind velocity nearly fifty miles per hour. Pushing on in the continuous cold, the remaining dogs developed dog madness and the party was compelled to return. After wintering at the base Peary again set out in April, 1895, and this time reached Independence Bay. Profiting by the experiences gained during his first trip across the inland-ice in 1891-92, the course was this time laid between the former outgoing and returning courses, with the object of avoiding the basins of exudation with their heavy slopes and crevassed ice, and also the deep soft snow which made difficult sledging in the interior areas. For this journey Peary by reason of the disaster which had befallen him in the loss of his supplies, was absolutely dependent upon a supply of meat from musk oxen which he expected to secure near Independence Bay, where he planned to recuperate before setting out upon the return. In this plan he was successful and the return was made without encountering any delay from blizzards, a most unfortunate circumstance, since all his provisions and one of the dogs were consumed upon the journey. During this Arctic expedition he carried out a thorough ethnological study of the little tribe of Eskimo highlanders on Inglefield Gulf.

Returning to the United States from this expedition he brought back with him the two smaller meteoric irons which he had discovered at Cape York. The largest mass, weighing about ninety tons, he was able to bring away only after he had made two special summer expeditions for the purpose. The first of these made in 1896 succeeded insofar only as to get the mass out of its bed and transported to the shore. At this juncture the pack began to drive and forced a sudden departure of his ship in order to escape being crushed. In 1897 a second expedition under his direction was successful in embarking the great meteorite and transporting it to New York City where it now rests.

Referring to the work accomplished by Peary up to this time, Sir Clements Markham, the veteran British Arctic explorer and the President of the Royal Geographical Society, said, "Lieutenant Peary is, without exception, the greatest glacial traveller in the world. He is also far and away the greatest dog-sledge traveller in the world as regards rapidity and distance."

In 1898 Peary set out upon his sixth Arctic expedition which was destined to extend over a period of more than four years and which, although it failed of its main object—the attainment of the Pole—will always rank among the most important of all Arctic journeys for what

was accomplished, and as a record of courage and fortitude in the face of heart-breaking discouragements it is unsurpassed.

In December, 1898, because of thick weather and heavy snows which held up the party on an expedition from Etah to Fort Conger, the supplies ran out. Pushing ahead with the strongest of the Eskimo, Peary reached Fort Conger after living on the dogs and going without sleep only to find that both his feet were so seriously frozen, that he had to lie upon his back throughout the winter. Lashed to a sledge he was dragged a distance of 250 miles in daily temperatures below —50° F. Arriving at the base eight of his toes had to be amputated; yet only a month later with the wounds still but partly healed he accomplished a second sledge trip to Fort Conger, and in this condition also he effected a crossing of the ice-cap of Ellesmere Land, which he had already shown to be continuous with Grinnell Land.

Before he could walk without distress it was necessary to break in a new set of tendons and muscles for both of his feet, and disagreeable though the process was, it was at last accomplished and the scars healed.

On the 9th of April, 1899, Peary started northeastward in an effort to reach the northeast corner of Greenland by way of the coast, and after meeting and overcoming the greatest difficulties he accomplished his purpose. Doubling the cape, to which he gave the name Cape Morris K. Jesup, he proceeded southward along the east coast of Greenland until he had sighted the high mountain (Mt. Wistar) which he had described some years before, when looking out from the height of the inland-ice west of Independence Bay. Thus, though he had not completely closed his two traverses, he conclusively proved the insularity of Greenland, and nine years later Capt. J. P. Koch of the Danish Northeast Greenland Expedition, advancing northward from Cape Bismark, mapped the intervening gap, and reaching Peary's cairn brought back to civilization the record which Peary had deposited there.

After the return from northeast Greenland to his base and still in the midst of winter, Peary on February 11th launched an attempt to reach the Pole, though this involved travelling four hundred miles in addition to what had lain before the earlier British expeditions in their attempts. On the trip to Fort Conger he covered the three hundred miles from Payer Harbor to the fort in twelve marches. With temperatures ranging from —40° F. to —67° F., four days were spent at the fort in fruitless attempts to secure musk oxen. On February 24th Peary started northward with nine sledges and on April 6th, after being in the field a month and covering four hundred miles of the most arduous travelling imaginable, he left the land at Crozier Island and struck northward across the pack in the direction of the Pole. After fifteen days of heart-breaking labor with dogs now about used up, he turned back on April 21st after attaining lat. 84° 17′ N., the highest

then reached in the Western Hemisphere. He entered in his diary: "The game is off. My dream of sixteen years is ended. . . . I have made the best fight I knew. I believe it has been a good one; but I cannot accomplish the impossible."

When in an address before the Royal Geographical Society, Peary had finished his narrative of this expedition, Admiral Sir Lewis Beaumont, himself a veteran Arctic explorer, declared: "I am glad to say that there is no jealousy among Arctic explorers, and if there is anyone here tonight who is ready to give him the meed of praise he deserves, it must be those who have had the privilege of being in those regions themselves. I think you will agree that to be four years in the Arctic Region is in itself a wonderful test of manhood and endurance, and to have accomplished in addition to those four years the extraordinary and wonderful journeys which we have just been told of, makes a record in Arctic history which stands almost unsurpassed. . . . I want you to appreciate how great was the work done by Commander Peary; that, starting from half way down Smith Sound 400 miles from the starting point of the three other expeditions, he has accomplished more than they. I consider it due first to the man himself who has shown himself every inch a man. . . ."

Undismayed by repeated disappointments in earlier expeditions, and notwithstanding the fact that he had now passed the age when men are considered fit to endure the continued hardships of polar work, Peary organized his seventh expedition to conquer the Pole. All the experience of his earlier expeditions was fully utilized, and this time a special type of ship, the "Roosevelt," was designed by Peary and built with a view to withstanding ice pressures and take the expedition through the dangerous Kennedy and Robeson channels to a base on the northern coast of Grant Land, from which the start could be begun at once upon the pack of the central polar sea.

A system of supporting parties described below under his last expedition was now for the first time devised and put into use in polar work. The expedition sailed north in July, 1905, and returned in October, 1906, after reaching the extreme northern latitude of 87° 6′, the farthest north by 38 statute miles that had ever been attained.

After leaving the shore of Grant Land and entering the pack, the party encountered much open water and was repeatedly held up by extensive leads, so that progress was very slow. Near latitude 85° a furious gale was encountered which continued for six days and drifted the party seventy miles to the eastward, so that it now became obvious that a dash from this point offered the only hope of attaining the Pole. On this dash, Peary reported, "as dogs gave out, unable to keep the pace, they were fed to the others. On April 20th we came into a region of open leads leading nearly north and south, and the ice motion

became more pronounced. Hurrying on between these a forced march was made. Then we slept a few hours, and, starting out again, soon after midnight, pushed on till noon of the 21st. My observations then gave 87° 6′.

"I thanked God with as good a grace as possible for what I had been able to accomplish, though it was but an empty bauble compared with the splendid jewel for which I was straining my life. But, looking at my remaining dogs and the nearly empty sledges, and bearing in mind the moving ice and the unknown quantity of the big lead between us and the nearest land, I felt that I had cut the margin as narrow as could be reasonably expected."

The return to the land proved to be full of peril, and it was reached on the shore of Greenland with food entirely exhausted. Here Peary was fortunate in finding a herd of musk oxen and in killing all seven of them, so that the party secured a meat supply sufficient to reach the base at Cape Sheridan. No man had been lost and 41 of the 120 dogs returned. Before returning to the United States Peary undertook a long sledge journey westward from Cape Sheridan and then completed the exploration of the entire northwest coast of Grant Land to Cape Thomas Hubbard. It was from the top of this promontory that he observed far to the westward what seemed to be a land sky upon the basis of which he gave out the probability of a new land mass which he called Crocker Land. The later expedition by Macmillan indicated that this does not exist, though from the height of the promontory Macmillan received the same impression that Peary did.

In July, 1908, Peary started on his eighth and last expedition in which he finally perfected the plan of supporting expeditions for journeys across the Arctic pack. On this expedition he established his base at Cape Sheridan and entered the pack near the same point as before. This time he reaped the harvest from years of determined effort and achieved the Pole. With twenty Eskimo men, seventeen women, ten children, 246 dogs, and a large supply of walrus meat, the "Roosevelt" reached its winter quarters through the heavy ice runs in Robeson Channel, and a depot of supplies was at once laid down at Cape Columbia, the northernmost point of the Arctic archipelago. The early part of the following winter was devoted to hardening his men by undertaking frequent winter sledging trips, with the result that when the expedition started in the late winter every man and dog was "lean and flat-bellied as a board and as hard." Peary's plan to achieve his purpose consisted in organizing four supportng parties to the main party which alone was to attempt to reach the Pole. For the first lap of the journey supplies for the entire expedition were to be taken from one sledge until only enough was left upon it for its return, whereupon with the least fit of the dogs and men it should return to the base.

The same process was applied in the case of the other supporting sledge parties in succession until Peary with the very fittest of men and dogs and with ample supplies upon the main sledge should make his dash for the Pole. The results proved the wisdom of the plan, which worked out almost to perfection, notwithstanding the fact that the party was held up for six days at the "big lead" which forms over the edge of the continental shelf. By having one party sleep while the next succeeding one was travelling, one set of snow huts were used for both and much time saved, the advanced party turning out of the *igloos* when the following one arrived.

When in latitude 87° 48′ at a point distant 130 miles from the Pole, Captain Bartlett who commanded the last supporting party, turned back and Peary wrote, "With the disappearance of Bartlett I turned to the problem before me. This was what I had worked for during twenty-three years; for which I had lived the simple life; for which I had conserved all my energy on the upward trip; for which I had trained myself as for a race. . . . Underlying all these calculations was a recognition of the ever present possibility of open leads, and impassable water, and the knowledge that a twenty-four hours' gale would knock all my plans into a cocked hat, and even put us in imminent peril." When at last with Henson and four Eskimos Peary had accomplished his dash in five marches and reached the Pole on April 6, 1909, he wrote in his diary:

"The Pole at last! The prize of three centuries, my dream and goal for twenty years, mine at last! I cannot bring myself to realize it.

"It all seems so simple and commonplace. As Bartlett said when turning back, when speaking of his being in these exclusive regions, which no mortal had ever penetrated before:

"'It is just like every day!'"

When he had spent thirty hours in making observations at the Pole and had undertaken a deep sounding at a point five miles distant and found no bottom at 1,500 fathoms, the back trail was taken and Cape Columbia reached in sixteen forced marches. Once safely across the "big lead" and upon the land-ice of the glacial fringe without the much feared gale having intervened, the Eskimos of the party went wild with delight and relief, danced and sang, and Otah exclaimed feelingly, "The devil is asleep or having trouble with his wife, or we never should have got back so easily." Such wind as was encountered on the journey had fortunately been from the north, thus keeping the ice pressed against the land and the leads generally closed. The weather, which had so often before dashed Peary's hopes, now for once had greatly favored him.

The scientific results of the expedition, in addition to proving the central polar sea, included a number of soundings which showed that

the continental shelf, unlike that in moderate latitudes, was characterized by landward as well as seaward slopes, a fact proven also for the eastern slope of Greenland by the observations of the Danish Northeast Greenland Expedition concluded the year before.

No sooner had Peary returned to the frontiers of civilization than he learned with astonishment that Dr. Frederick A. Cook had shortly before put forth the claim to have reached the North Pole nearly a year in advance of himself. No account of Peary's life could fail to take account of an event which bulks so large as the so-called "Cook-Peary Controversy," and, painful as it will always be for American geographers to recall it, the smouldering embers of popular distrust and misinformation demand imperatively that at least the salient facts in the greatest of scientific fakes should be here reviewed.

Dr. Frederick A. Cook at the time of Peary's conquest of the Pole had been a member of several polar expeditions, notably that of the "Belgica" expedition to the Antarctic in 1897-99 and of Peary's expedition to North Greenland in 1891-92. He had also between 1903 and 1906 directed several expeditions in attempts to ascend Mt. McKinley in Alaska and had made the claim to have ascended the mountain in 1906 in company with one guide, after the main expedition had been disbanded. His alleged photograph presenting the summit at 21,000 feet of altitude showed soft snow, in appearance quite unlike the hard-packed snow of the summits of high peaks.

At some time previous to Peary's return from his successful polar expedition (August, 1907, according to Cook), Cook had been landed from a private yacht on the shores of Smith Sound, and in the company of Eskimos had made an excursion westward across Ellesmere Land. This much seems to be well established by the testimony of his companions and through his examination by Captain Sverdrup at Copenhagen. According to his claims he accomplished the thirteen hundred miles to the Pole and return, whereas the Eskimos who were his companions testified that he went "two sleeps" only on the ice before returning. When Captain Bartlett returned to the base with the report that he had left Peary 130 miles only from the Pole, Cook hurried back to civilization with the announcement that in April, 1908, or nearly a year before the date of Peary's arrival at the Pole, he had himself reached it. Peary, as soon as he got in touch with outside communications, declared the claims of Cook to be unfounded upon the basis of the testimony of the Eskimos who had been Cook's companions. Should Cook's claims be established, the reward would be almost entirely his, because of his alleged priority in attaining the Pole. None the less, Cook's clever retort that there was "glory enough for all" made a strong appeal to the American sense of fair play, since the American public was wholly unable to form a competent judgment

of the merits of the controversy. The followers of Cook in the contest which soon developed were especially numerous among the so-called "intellectuals," and no less than four well-known polar explorers gave their full endorsement to Cook during the early stages of the controversy. These were General Adolphus W. Greely, who had commanded an American polar expedition; Captain Ronald Amundsen, the distinguished Norwegian explorer; the well-known Danish explorer, Knud Rasmussen; and Captain E. B. Baldwin, who had commanded the Baldwin-Ziegler expedition to the Arctic in 1901.

Cook, instead of returning from the Arctic directly to the United States, took ship to Copenhagen, where Rasmussen's endorsement secured for him a great ovation. He was received in state by the crown prince of Denmark, the keys of the city were delivered to him, and the famous University of Copenhagen conferred upon him her Doctor of Laws. In the presence of vast throngs of the populace wreaths of laurel were hung about his neck. When the rector of the University requested that he be allowed to inspect the records made at the Pole, he was informed by Cook that these precious documents had been left in Northern Greenland in the keeping of a hunter of musk-oxen who was instructed to deliver them to Peary to be by him brought back to the United States on the "Roosevelt." Peary, knowing well that when they were found to be spurious he would be charged with having tampered with them, wisely refused to fall into the trap which was thus laid for him, for which he was denounced to the public as ungenerous to his rival.

Acclaimed at Copenhagen, Cook's arrival in the United States and his appearance before large audiences throughout the country, afforded him ovation after ovation and netted him great financial returns.

Anxious to end as soon as possible a disgraceful situation, though Peary with dignity had refused to take any further part in the controversy, the National Geographic Society appointed a committee of distinction and of much technical expertness to examine the records of Commander Peary. This committee consisted of Mr. Henry Gannett, chief geographer of the United States Geological Survey; Admiral Colby M. Chester of the United States Navy, and Superintendent O. H. Tittmann, the head of the United States Coast and Geodetic Survey. When invited to submit his records, Cook refused upon the ground that he had already promised to submit them first to Copenhagen. By cable the society then requested the University of Copenhagen to waive its rights under this promise so that the disagreeable controversy might be brought to an end, but its rector declined to accede. So the great lecture tour of Dr. Cook went on and the newspapers of the country continued to advertise the fraud in front-page articles.

When the evil day could no longer be put off, Cook submitted his

papers to the tribunal of his own choice at Copenhagen with the result that they were found to supply no proofs whatever, as was thereupon officially announced by the University. Rasmussen, whose endorsement had been largely responsible for the humiliating position in which this famous University now found itself, declared in an interview: "When I saw the observations, I realized that it was a scandal. The documents which Dr. Cook sent to the University are most impudent. It is the most childish sort of attempt at cheating."

Perhaps the most convincing proof of the gigantic fraud which had been perpetrated by Dr. Cook upon a susceptible public has been supplied by the discoveries of the explorer Stefansson, who, subsequent to the settlement of the controversy, discovered and explored a body of land lying directly athwart the path alleged by Cook to be the one he followed; and a point which Cook claimed to have located with especial accuracy and to represent the frozen surface of the sea, Stefansson found to be situated well inland from the coast of this newly discovered land and at an elevation of 800 feet above the sea.

As regards the alleged ascent by Cook of Mt. McKinley, Professor Herschel C. Parker of Columbia University, who had been a member of the earlier Cook expeditions, later led an independent expedition to the district and prepared photographs which show that the peak represented by Cook's published photographs to be the summit of Mt. McKinley is distant from it about twenty miles and has an elevation of about 8,000 feet, instead of 21,000. The late Arch-Deacon Stuck, who subsequently made the first ascent of Mt. McKinley, wrote in his narrative, "any one who climbs to the top will not need Edward Barrille's affidavit to convince him that Cook's narrative is untrue."

As a consequence of these exposures of fraud, the Alpine and Explorers' Clubs, the Arctic Club of America, and the Council of the Brooklyn Institute of Arts and Sciences, all by formal action, formally expelled Cook from their membership. Notwithstanding the exposures, Cook through his agents in Congress tried repeatedly to have action taken to declare him the discoverer of the North Pole, but succeeded only insofar as to have speeches denouncing Peary entered upon the congressional records.

The narrative of his journey and the observations made in the vicinity of the Pole were by Peary submitted to the expert boards selected by the National Geographic Society of Washington and to those of the Royal Geographical Society of London, as well as to a special committee of experts chosen by a congressional committee of investigation. All these boards alike reported that the evidence submitted fully substantiated all the claims of the explorer. The President of the Royal Geographical Society, when introducing Peary to the Society for an address upon the results of his expedition and for

the award of a second special gold medal, said: "I stand here tonight as the representative of the Royal Geographical Society, and armed with the full authority of the Council, to welcome you, Commander Peary, as the first and only human being who has ever led a party of his fellow creatures to a pole of the earth."

Admiral Sir Lewis Beaumont, in seconding the vote of thanks of the Society to Commander Peary, said:

"Commander Peary began by showing that he had in him all the personal qualities which enable a man to make great sledge journeys to the polar regions—in his fifteen years' work since he has shown that he also possesses the much higher qualities of rapid organization and good generalship.

"Under his leadership the zeal and enthusiasm of beginners have been made to accomplish the work of veterans—all the energy that has come within the sphere of his influence has been made to converge upon one subject; and while he has remained the brain, guide and commander, the work done by his assistants has been full of independent initiative and intelligence."

Captain Robert F. Scott, soon to forfeit his life to the hardships and perils of polar exploration just after achieving the opposite pole of the earth, said on the same occasion:

"I esteem it a great privilege to have been asked to support this motion (a vote of thanks of the Society to Commander Peary). It has been most fittingly proposed and seconded by three British explorers who have gained their laurels in the regions in which Commander Peary has achieved his great triumph. It is well that those who are most competent to judge should record their enthusiastic admiration of the unquenchable spirit with which Commander Peary has pursued his object, and their appreciation of the justice of the reward which has at length crowned his efforts."

Peary himself in evaluating his achievement said:

"Many factors have entered into the success of the expedition, but standing preeminently was *experience*. . . . In a previous expedition for the first time a true knowledge of actual conditions existing in the Central Polar basin had been secured; and with this combination it was possible to provide for practically every contingency. Added to this was the fortunate factor of a not unusual depth of snow on the icefields to impede us and the non-occurrence of strong easterly or westerly winds while we were on the ice. The occurrence of such winds, resulting as they would, in pronounced lateral motion of the ice, would have given us serious trouble."

Looking back over the expeditions as a whole, it is manifest that each led to new knowledge vital to success, which was fully made use of by Peary in all the later onsets of his campaigns. Throughout a

lifetime he had pitted himself against the cruel forces of Nature in these inhospitable regions, and out of repeated defeats he had at last achieved victory. For this, notwithstanding his mutilated members, his magnificent physique was a prime requisite, and though impaired by advancing years when the last battle was fought, he yet made it adequate for the task by simple habits and a spartan self-discipline.

Among geographers the recognition of his work followed upon his achievement of the Pole, though he had already been the recipient of many honors and of special gold medals in addition to those commonly awarded by the geographical societies. Now every important geographical society in the world in some way gave indication of its recognition of Peary's service to science. Special gold medals were awarded him by the National Geographic Society (Washington), The Royal Geographical Society (London), Philadelphia Geographical Society, Peary Arctic Club, and The Explorers Club (New York). The National Geographic Society awarded him in addition the Hubbard Medal, the Chicago Geographical Society the Culver Medal, the Philadelphia Geographical Society the Kane Gold Medal, the American Geographical Society (New York) the Daly and Cullom Gold Medals, and gold medals were awarded him by the Imperial German, Austrian, Hungarian, Royal Scottish, Italian, and Belgian geographical societies, not to mention many smaller organizations. Other honors came to him in the election as President of the American Geographical Society (1903), President of the 8th International Geographical Congress held at Washington in 1904, Honorary Vice-President of the 9th International Geographical Congress held at Geneva in 1908, and also the 10th held at Rome in 1913. He was elected President of the Explorers Club and later served as delegate of the United States government to the International Polar Commission which met in Rome in 1913. France recognized Peary's great triumph by making him a Grand Officer of the Legion of Honor.

When the special congressional investigating committee of experts which had been appointed to examine Peary's observations at the Pole had reported favorably, by special act a vote of thanks was extended to Peary by the Congress, and he was promoted to the rank and pay of Rear Admiral in the United States Navy.

Yet all these honors, great as they were and coming from those most competent to judge of the merits of his work, never fully compensated for the campaign of vindictive defamation which had been set on foot by Dr. Cook and which, kept up unceasingly almost until his death, estranged a large section of the American public and prevented a general recognition of his patriotic service just where he most yearned to have it. For the benefit of his countrymen the writer of this sketch feels constrained to describe the remarkable ovation which was ten-

dered Peary at the 10th International Geographical Congress held in Rome in the spring of 1913. This Congress was attended by an especially distinguished body of polar explorers, among them Stefansson, Cagni, and Bruce. It having early been rumored that Peary was to be in attendance, the writer found himself besieged by anxious inquirers to know whether it was really true. When Peary arrived it almost seemed as though other activities were forgotten, so great was the interest in seeing or meeting the great explorer. Dinners in Peary's honor were tendered in such rapid succession by the delegates from the different nations represented as to constitute a distinct strain upon him, from which he at last found relief in an excursion with the writer into the Roman Campagna.

The motive power which lay behind Peary's repeated determined attacks upon the Pole was a deep patriotic sentiment quite as much as it was his desire for personal success. Speaking before the Royal Geographical Society after his great disappointment of 1902, he declared, "The attainment of the Pole is peculiarly an object for American pride and patriotism. The North American world segment is our home, our natural ultimate destiny."

With the outbreak of the great war in Europe Peary threw himself into the campaign for preparedness, for with clear vision he saw in it the only sure way of meeting the peril which hung over his country and civilization itself. He spoke with great earnestness to many large audiences, and was often called upon by the Navy League and by other defense organizations to speak at their preparedness conventions. At other times he addressed large audiences from the same platform with General Wood.

The Aero Club of America appointed him one of its governors, and he became the principal protagonist for a coast patrol by seaplanes to guard the Atlantic seaboard against surprise, a system which was eventually put into force and taken over by the federal government.

In 1918 Peary was stricken with pernicious anemia and after thirty-five transfusions of blood had been made in succession to prolong his life, he passed away at his home in Washington on February 20, 1920, at the age of sixty-four years. At his bedside were the members of his immediate family: Mrs. Josephine Diebitsch Peary, who had more than once been his companion on Arctic expeditions; his daughter, Mrs. Edward Stafford, the "snow baby" who had been born in the Arctic; and his son, Robert Peary. He was buried in Arlington National Cemetery with full naval honors.

Thus passed from earth all that was mortal of the man whom Stefansson described as "easily the greatest of all explorers, North or South," and one who was loved for his sterling personal qualities by all who were privileged to know him intimately. His qualities of

leadership have been referred to by Captain R. A. Bartlett, the commander of the "Roosevelt" and one who knew him as did few others: "The Admiral was a born leader. . . . In every emergency during his trips he always thought of the welfare of his men first and of himself last. . . . I know of innumerable cases where he denied himself necessities to supply his men."

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ANNALS OF THE ASSOCIATION OF AMERICAN GEOGRAPHERS
Volume XI, pp. 109-111

MEMOIR OF SUMNER WEBSTER CUSHING

ELLSWORTH HUNTINGTON

Geography and mathematics are the only sciences which enter extensively into education at all ages. In mathematics the logical mode of procedure from the simple to the complex is so thoroughly established that it has ceased to be a problem. Geography, however, is still growing not only at the top, as in mathematics, but in every direction. Many of the new ideas of the most advanced investigators at once become a part of elementary education, as happened, for example, with the concept of cycles of youth, maturity, and old age. Because the subject is in such a state of flux there is grave danger of mistakes; the elementary teachers are often carried away by a laudable but mistaken enthusiasm for the new, even when it is far too mature for their pupils, while the advanced teacher is too elementary. Hence, among the many and pressing needs of modern geography one of the greatest is men who know the whole range of the subject and can see it with the eyes of the eight-year old child, the college student, the teacher, and the highly trained investigator.

Sumner Webster Cushing was one of the few men who had this power of seeing geography with the eyes of all ages. He was fitted to do this by training and occupation, by scientific achievement, and by personality. To begin with training and occupation, Mr. Cushing was born in Norwell, Massachusetts, December 30, 1879, the son of Webster A. and Amanda Cushing. He was graduated from the Brockton High School and the State Normal School at Bridgewater. In 1903, after a two years' course at Harvard University, he received the degree of B.S. He then taught, in successive years, the subjects of science, mathematics, and physical geography in the high schools of Wakefield, Mass, Waterbury, Conn., and Providence, R. I. While in Providence he studied at Brown University and received his master's degree.

In 1907 he became the head of the geography department at the State Normal School in Salem, Mass. To quote from Mr. Pitman, principal of that school, " In addition to his classes in geography in the normal school, he supervised the work in the training school, made out a course of study for the guidance of the student teachers and the supervisors of the grades, and kept in close touch with the work of the children. His field trips and excursions to industrial plants added greatly to the interest in the subject both among the children and among the students in the normal school. His students will never forget the delightful trips to Devereux Beach, nor the more strenuous excursions devoted to tracing the course of Forest River. He was untiring in his plans to present subjects of general interest to the

entire school by lectures, lantern slides, and motion pictures. In every possible way he strove to make the subject of geography alive and to show its importance in understanding the trend of civilization. He succeeded to an unusual degree, for his students speak of him as a wonderful teacher." In addition to his work at Salem, Mr. Cushing taught geography at Wellesley College from 1911 to 1913, and gave summer courses at several universities—Illinois, 1910 and 1914; Columbia, 1912, and Miami, 1917. He was also on various committees of the Massachusetts State Board of Education and the National Council of Geography Teachers for the preparation of courses of study in elementary, high, and normal schools. Thus in both his education and his teaching Mr. Cushing came in contact with every phase of geographical education.

Mr. Cushing's career as a scientific investigator began with his attendance at the summer session at Harvard in 1907. As Professor Davis puts it: "A praiseworthy ambition to advance in his chosen science led him to spend the next summer in France, studying the Central Plateau with his former Harvard professors, W. M. Davis and D. W. Johnson. Similarly his vacation in 1909 was spent in an examination of the coastal features of Maine, during which he traveled in and out along the coast some 1500 miles. His statement of the results of this work before the Geological Conference at Harvard led to his securing a Sheldon travelling fellowship from the Harvard Graduate School, which enabled him, while on leave of absence from Salem, to visit India in 1910-11, for the investigation of a special geographical problem in the region of Madras. His report upon this problem, "The East Coast of India," presented at a meeting of the Association of American Geographers in 1911, attracted highly favorable notice as far and away superior to any previous description of the Madras coast. Its publication at once gave him an assured position as a professional geographer." Later work on Japan and New England, and upon many problems in commercial and industrial geography confirmed this position.

In his personal relations Mr. Cushing was at his best among his students. There he lost a certain shy reserve which sometimes partly concealed a really remarkable sweetness of disposition. When he came into intimate contact with his fellow geographers, as he did, for example, during the Transcontinental Excursion under the auspices of the American Geographical Society in 1912, he was revealed as a man of most genial sympathies, unusual courtesy and great modesty, with decided opinions but holding them in the true spirit of humility which is ready to acknowledge mistakes and profit by the advice and experience of others. That excursion broadened him greatly, as did his marriage in 1913 to Miss Frances B. Deane. She had been a teacher of history in the Salem Normal School, and her historical knowledge and

literary ability were a great help to Mr. Cushing. Of even more importance was the fact that she strengthened his confidence in his own powers, for he often underrated himself. Another experience which had a similar broadening and strengthening effect was a year's service as Captain in the Military Intelligence Division of the General Staff in Washington, from July, 1918, to July, 1919. As General Churchill, his chief, well said, he left behind him "a record of marked ability, and fine devotion to duty. He endeared himself to all his associates."

In Mr. Cushing's own opinion all his work up to about 1914 was merely preparation for his great life purpose. That purpose was to help create the right relation between geographical research and teaching, and between the teaching in one stage of education and another. Most of his program to this end was perforce left unfinished. Judging by his articles and addresses and especially by his phenomenal success in inspiring normal school students and elementary teachers, his projected book on the teaching of geography and the use of problems would have marked an important step toward the goal of satisfactory geographical teaching. Something of its character may be judged from a "Teacher's Manual of Geography for Grades VII and VIII," which was distributed broadcast by the Massachusetts State Board of Education and for which there was a great demand in other states. Although the Manual was ostensibly prepared by a committee, Mr. Cushing was the moving spirit, and the ideas and methods of the book are largely his. Another place where Mr. Cushing's educational ideas are firmly embedded is in the "Principles of Human Geography," of which he was joint author with the present biographer. To that book, which unfortunately did not appear until after his death, Mr. Cushing contributed the major part of whatever pedagogical value it may have. Another joint book, "Commercial and Industrial Geography," was nearly completed at the time of Mr. Cushing's death. To this he contributed the general plan, the method of presentation, and a large share of the text.

In all his work Mr. Cushing insisted first on absolute accuracy, for he was supremely truthful. He also insisted on orderliness, and on the idea that the mind of the student must work with that of the teacher. It is most impressive to hear his former pupils say, "Mr. Cushing made me think of that." He put his mark on his students and all who came in close contact with him because of his enthusiasm, for above all things he was an enthusiast. His enthusiasm was not merely for geography nor for teaching, but for the right relation of the two. His death leaves uncompleted a great piece of work for which he possessed a rare training. His sympathetic personality was fast making that training most effective in bridging the gap between the leaders of scientific investigation and the teachers through whom geography filters down into the common consciousness of mankind.

ANNALS OF THE ASSOCIATION OF AMERICAN GEOGRAPHERS
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MEMOIR OF FREDERIC PUTNAM GULLIVER

WILLIAM MORRIS DAVIS

Frederic Putnam Gulliver was born at Norwich, Connecticut, on August 30, 1865, the son of Dr. Daniel Francis and Mary (Strong) Gulliver, the fifth of eight children, of whom four survive him. His father was a native of Boston, a graduate of Yale in 1848, and of the Jefferson Medical College in Philadelphia a few years later; on account of ill-health he early gave up the practice of his profession and devoted himself to farming and stock raising. Gulliver's mother was descended from some of the original settlers of Norwich, including Huntingtons, Edgertons and Traceys; her family always lived in the town and city since its foundation. Through her, her son is related to Ellsworth Huntington, this being one of the few cases of cousinship among our members.

After preparatory schooling at the Norwich Free Academy, Gulliver entered the Massachusetts Institute of Technology in 1883 and studied mining engineering until 1886; then having acquired a considerable skill in topographic surveying and without waiting for a degree, he secured an appointment as field assistant in the topographic branch of the United States Geological Survey, and was promoted to the rank of topographer in 1889. The districts he surveyed were all in eastern states. His ability to "see country" and to portray it upon maps of different scales led to his being placed in charge of field parties, in which some of the assistants were double his age and were receiving twice his salary. This work gave him expertness, but did not offer satisfactory prospects of advancement or sufficient scope for his scientific interests; it led him, however, to feel the need of further education and especially of a fuller knowledge of the features of the land upon which his work had been performed; but the immediate cause of his resignation from the Survey in 1891 was ill-health, apparently induced by something like a sunstroke. When he became well enough for study, he concluded that his interests were on the scientific rather than the topographic side of geography, and definitely adopted teaching as his aim. In preparation for this career, he decided to study at Harvard, where he was admitted to advanced standing in the College in 1892 and received the degree of A. B. with the class of 1893. Then wishing to equip himself still more fully in his chosen subjects of geology and geography, he registered in the Graduate School, where he received the degrees of A. M. in 1894, and of Ph. D. in 1896. His genial nature and his sincere interest in his studies made him welcome among students and teachers alike.

During these years of graduate study, Gulliver's topographic skill was shown in the construction of two models of a well developed

glacial sand plain and its feeding esker in Newtonville, near Boston; one model presented the actual form of these features on the basis of original sketch surveys; the other added the supposed attitude of the ice sheet while the feeding esker and the outwashed delta plain were in process of formation at its slowly retreating margin. These models served as the basis of Gulliver's first published article.

It was also during this period of graduate study that Gulliver spent the summer of 1894 as assistant geologist on the U. S. Geological Survey, when he had the good fortune to work under G. K. Gilbert on the Apishapa quadrangle in Colorado, the Folio of which bears his name with others. Owing to his previous experience in surveying, he was largely occupied in making plane-table maps of special areas where the structure was too complicated to be shown on the base-map scale, or where the base map was unusually inaccurate. He also measured sections and computed the thickness of formations and traced their boundaries. He is described by an associate of that summer as an interesting companion in camp, full of stories, and always ready to discuss problems and theories. Mr. Gilbert, in a letter written during the summer, said of him, "He is a charming fellow, gentle, cultured, able and in every way companionable." One of the results of this season's field work was a joint paper with Gilbert on "Tepee buttes," or wigwam-like residual knobs that surmount the degraded plains where localized accumulations of fossil shells resist erosion.

During other vacation months Gulliver examined the district around his home city of Norwich, Connecticut, and reached the conclusion that, after the general peneplanation of the region as recorded in the uplands, several subordinate low-grade surfaces of much smaller area were produced during pauses in the uplift of the region; thus he in a measure anticipated the more definite results later reached by Barrell for the same state.

For the last two years of his graduate study, Gulliver was closely associated with the writer in an investigation of "Shoreline Topography," which he had chosen for a thesis and to which he gave the most persevering and successful attention. He made a thorough review of all previous work on this attractive subject, devised a general and comprehensive scheme of treatment for it, and applied the scheme assiduously in the description of actual shore lines as represented on large-scape maps and charts of many parts of the world. The scheme took account of a multitude of detailed features which follow from the general principle that the forms of a coast are dependent, first, on a movement of the earth crust or a variation of ocean level, whereby a previous land surface is partly submerged or a previous sea bottom is partly emerged; and second, on the fairly systematic sequence of changes that a new shore line thus originated will suffer as determined by its structure and by the nature of the agencies operating upon it.

It was in this connection that he introduced the excellent terms, initial, sequential, and ultimate, as designating the first, intermediate, and final stages of not only the cycle of marine erosion under which coastal forms are produced, but of all cycles of land erosion by whatever agency. He also showed clearly that such terms as young, mature, and old, which apply so well to successive stages in the cycle of subaerial erosion, apply equally well to the cycle of marine erosion; further, that every change in the attitude of a coast or in the level of the ocean must, in lesser or greater degree, interrupt the progress of the cycle of shoreline development previously current and introduce a new cycle; hence the old forms that would theoretically characterize the far advanced stages of the marine cycle should be and actually are less frequently found than the old forms of subaerial erosion in continental interiors, where erosional processes are less sensitive to changes of land attitude. While these studies were in progress, he made a special examination of a peculiar group of littoral forms which result from the interaction of eddying shore currents, and which he called "cuspate forelands." They formed the subject of a valuable article which appeared in the Bulletin of the Geological Society of America. His thesis, published three years later in the Proceedings of the American Academy of Arts and Sciences at Boston, has been frequently and favorably cited; it contains a large store of examples, taken chiefly from maps and charts, and classified according to his systematic scheme for the ready illustration of shoreline forms.

On completing his graduate studies, Gulliver received a Harvard Travelling fellowship and passed a year in Europe, where he spent the fall semester at the University of Berlin under von Richthofen, and the spring semester at the University of Vienna under Penick; he also visited a number of other universities for the purpose of consulting their professors of geography on his special subject, and he examined certain coastal districts that were of special interest as exhibiting typical examples of one stage or another in shoreline development. A large cuspate foreland, known as Dungeness, on the southeast coast of England was examined in detail and described in the Geographical Journal of the Royal Geographical Society with more appreciative recognition of its form and its origin than it had previously received in print. This foreland had attracted his attention because the review that he had made of coastal charts had discovered two other similar forelands of the same name, one in the Straits of Magellan, the other in Puget Sound, which had evidently been so designated by British navigators because of their resemblance to the home type. His letters during this period of travel and observation were warmly expressive of the courtesy with which he was received in his university visits, and of the stimulation gained by his personal and coastal experiences.

After returning from Europe in 1897, he was appointed a master at St. Mark's School, in Southborough, Massachusetts, where he remained eight years, teaching physiography, meteorology and botany to the older boys, and leading the younger boys into elementary general science, largely by outdoor lessons and field observation. His frank enthusiasm and good fellowship gained him the affectionate regard of his pupils, but his gentle nature was little fitted to restrain the unruly behavior of some of them, and his classes were not noted for strict discipline. One of his entertainments during this period was pruning of the trees in a neighboring apple orchard which an old-fashioned farmer had left to their own habits of growth. His shore line studies were continued in the summers, especially regarding the island of Nantucket, of which he published a brief account; in 1904 he contributed a paper on "Island Tying" to the International Geographic Congress held in Washington.

After resigning from St. Mark's, Gulliver resided chiefly at his old family home in Norwich. For the remainder of his life, it seemed as if uncertainty regarding his health discouraged his seeking formal engagements or entering upon large undertakings; but his interest having been aroused in the improvement of geographical teaching in the public schools, he gave much time to the planning and preparation of a text book on the geography of a city, which, as many school children attend city schools, should serve as a beginning for the extension of rational geographical ideas to other parts of the world; this task, however, was not carried to completion. In 1909 he served as chairman of the Historical Committee for the 250th anniversary celebration of the founding of Norwich, and was appointed editor of the commemorative volume, but this duty he was unable to fulfil. He later accepted appointment as geographer on a State Commission in Pennsylvania, charged with the suppression of a blight by which the chestnut trees of that and the adjoining states were nearly exterminated; but his health was then failing and he died in Philadelphia, on February 8, 1919.

During these later years of his life Gulliver's devotion to geographical and geological science led him to continue the relations already formed with others of similar tastes. Having taken membership in the American Association for the Advancement of Science several years before, he served as secretary for Section E, Geology and Geography, in 1902, 1907-09 and 1911. He was also a member of the Geological Society of America and of the Association of American Geographers, and was especially interested and active in the meetings of the latter organization.

It is a misfortune for geographical science in America that one whose preparatory studies were of so great promise had not longer life and greater strength for their full extension.

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ANNALS OF THE ASSOCIATION OF AMERICAN GEOGRAPHERS
Volume XI, p. 117

MEMOIR OF WILLIAM CHURCHILL

CYRUS C. ADAMS

William Churchill was born in Brooklyn, N. Y. on October 5, 1859 and died in Washington, D. C., on June 9, 1920. Churchill was a philologist primarily. His life for several years in Melanesia, as Consul General at Samoa and Tonga led him into the study of ethnology and anthropology and gave him unusual opportunities for following his native interest.

This sojourn and study resulted in many ethnological and philological publications and earned for him honorary membership in several foreign learned societies. He felt in sympathy with the Pacific Islands, he looked backward to his life there with deep appreciation of his opportunities and looked forward to the opportunity of returning and carrying on what he considered his real life work and interest.

Necessity however caused him to devote much of his time to writing and editing for a living. For thirteen years he was a departmental editor of the New York Sun and during this period he contributed regularly and fairly abundantly to the Bulletin of the American Geographical Society.

On his infrequent appearance on the program of the Association he presented stimulating and interesting papers in a field which he alone represented in our membership. His interest being in life and life conditions he had little sympathy with the work of those who found their incentive for scientific work in the physical aspects of geography.

Owing to his first hand acquaintance with peoples, languages and regions of Melanesia, his services were of great value to the Government which he served during the war through the Committee on Public Information.

" Not only did he have what might be called an old-fashioned classical education but he was a natural born scholar, who pursued investigations in the language and ethnology of the Pacific region with the keenest enthusiasm during many years of newspaper work. His opportunity came only when his work was recognized by the Carnegie Institution, where he obtained support for a broad project of investigation into studies on the migrations of Pacific peoples in combination with Pacific philology. He had an almost boyish view of life and an intense interest in his friends and professional acquaintances, every one of whom treasures letters which he wrote under many different circumstances ranging from the happiest to the saddest. He had extraordinary powers in the way of focusing his attention upon technical problems of great complexity and represented a high type of scholarship exceedingly rare in this country."

TITLES AND ABSTRACTS OF PAPERS

CHICAGO, 1920

Herbert E. Gregory.

Presidential Address:—Geographic Basis of the Political Problems of the Pacific—Read by Title.

Cyrus C. Adams.

Memorial of William Churchill. Printed in full herewith.

Esther S. Anderson (Introduced by N. A. Bengston).

Population Changes in Nebraska Since 1880.

Changes in population of typical Nebraska counties since 1880 show the effectiveness of geographic controls. Types of changes have been dissimilar within the three physiographic regions, whereas within each division a general similarity is shown. The influences which have caused the variations are (1) climatic factors; (2) the nearness to railroads; (3) the introduction of drought resistant crops in the less humid regions; (4) the introduction of irrigation in western Nebraska; (5) adaptation of methods of cultivation; (6) the extension of small grain farming in eastern Nebraska; and (7) the use of more efficient machinery.

Wallace W. Atwood.

The Development of Productive Scholarship Among American Geographers.

In the development of productive scholarship in geology and the promotion of that great science the Federal Government and many of the state governments have furnished opportunities to the men entering that field of study to devote all of their time to research and the preparation of material for publication. Many geologists who have been engaged in educational work have had ample opportunity during the summer season to carry on actual research work and from time to time to publish their results. These conditions have, I believe, been essential to the development of productive scholarship in geology.

Geography needs a similar support and a similar productive scholarship in America. If geographers are given an equal opportunity will they not produce equally valuable results; will there not come to be in this country a body of men and women who have a first-hand knowledge of the distant parts of the world, and should not such members of the profession produce American literature on geography which is very greatly needed? For many people geography has come to mean a study of the ever-changing adaptations of people to their environment and it would therefore appear to be especially important that the

students of geography keep in close touch with the actual conditions in the various parts of the world, and have sufficient time and support for the development of productive scholarship.

Zonia Baber (Introduced by G. J. Miller).

The Distribution of Sunlight and Moonlight on the Earth.

The "Lands of Midnight Sun" and day-night moon are the critical areas of distribution of light from the point of view of life.

Since the variation in the length of the period of continuous light of the sun, or of the moon, depends upon the apparent declination of the sun and of the moon, it is evident that the critical area of sunlight remains approximately the same.

But the critical areas of moonlight must vary in size depending upon the place in the "Metonic cycle," for during the Metonic cycle, of about 19 years, the moon's turning points vary from latitude 18° 9′ North and South, to latitude 28° 44′ North and South. In the year 1904 of the present lunar cycle, the moon turned at latitude 18° 9′ North and South making a zone that saw the moon in the zenith of about 36° 18′. This zone increased in width from 1904 until 1913 when it reached a breadth of 57° 28′. After reaching the greatest extension of the moon's vertical rays, the lunar tropics moved equatorward. This movement will continue until about 1923 when the poleward movement will again begin.

During the month of December 1920 the lunar polar area extended 19° 29′ from the poles to latitude 70° 33′. The limits of these regions have but one day-night of continuous moonlight, but the centers have about 14 day-nights of moon-light.

Oliver E. Baker.

The Importance and Permanence of the Physical Factors in Determining the Utilization of Land for Agricultural and Forest Production. Printed in full herewith.

Louis A. Bauer.

The Status of the General Magnetic Survey of the Earth.

The paper first gave a brief summary of the work in investigations of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, during the period 1904 to 1920, with reference to the accomplishment of the task assigned to the Department—the general magnetic survey of the Earth. A brief account was also given of the work done during the same period by cooperating organizations and institutions.

Particular reference was made to the scientific and practical prob-

lems of ocean magnetic surveys, and it was shown how far the solution of these problems has been advanced. The slides showed the status of ocean magnetic surveys before the work of the Department of Terrestrial Magnetism and the progress since then.

It was further shown how the work of the Department of Terrestrial Magnetism has been planned so that both the theoretical and practical aspects of a magnetic survey of the Earth would receive adequate attention and that actual progress be made towards the solution of the outstanding greater problems pertaining to the theory and origin of the Earth's magnetism and of its never ceasing changes. In conclusion, brief statements were made of other scientific work accomplished aboard the magnetic survey vessel operated by the Department of Terrestrial Magnetism (detection of areas of local magnetic disturbance; atmospheric electricity; atmospheric refraction; meteorology; ocean currents; geographical discoveries).

N. A. Bengston.

Notes on the Geography of Honduras.

The topography of Honduras is characterized by (a) narrow coastal plains; (b) steep mountain fronts facing seaward; (c) interior mountain ranges that reach altitudes of 4000-8000 feet; (d) two series of terraces; and (e) dissected peneplains.

The climate varies with the topography and the terms rainy and dry seasons have distinct local applications. Industrial development has been largely concentrated where topographic barriers to transportation were wanting. Back of such barriers but a few miles is a people living as did those of four centuries ago in the same place. Future railway building is forecasted by the line of least topographic resistance —the great graben-like depression through the Cordilleras of the country.

Charles F. Brooks.

Cold Surf with Off-Shore Winds.

Reports of unusually cold water along the middle and north Atlantic coast of the United States during July and August, 1920, led to an examination of the wind and cloudiness records during these and immediately preceding months. It was to be expected that should there have been deficient sunshine and an unusual persistence of off-shore winds the surface water would not have been heated as much as usual, and it would have been blown rather rapidly out to sea, only to be replaced by the much colder water from below. Aside from the effects of an unusually cloudy June at Boston and a rather cloudy August at Atlantic City, the solar heating of the water was probably normal.

The wind conditions, however, stand out as the obvious cause of the coldness of the shore water. The wind at Atlantic City was more persistently off-shore in June and July than in these two months in any year since 1912. Similarly, the wind at Boston was strongly off-shore; in July there was five times as much off-shore as on-shore wind.

Robert M. Brown.

Census Maps of the United States, with Some Suggestions for Improvement for Use in Geography.—Read by Title.

Henry C. Cowles.

Ecology and Geographic Boundaries.

Henry J. Cox.

Rise in Temperature on Mountain Summits Earlier than on Valley Floors.

In a research conducted in the North Carolina mountains, by the Weather Bureau, a study was made of early rises in temperature at the mountain summits. Frequent instances are noted of rise at the summit during the night time before that at the base, and an occasional instance of rise at the summit when the temperature was still falling at the base.

These are most pronounced on isolated peaks, and especially those that have no relatively high mountains or plateaus immediately to the east or south which may shut off the winds from those directions. As a result of this phenomenon, inversions in temperature have been noted ranging from 10° to 30°. However, the rise seldom begins more than 10 hours earlier at the summits, and there are no instances of rises 24 hours in advance, as noted by McLeod in his studies of Mount Royal, Montreal, and by Clayton in his studies of Blue Hill. This is because the Carolina mountain region is not in any of the principal storm tracks, as are both Mount Royal and Blue Hill, where the influence of approaching depressions are earlier felt at a high elevation.

D. H. Davis (Introduced by Carl O. Sauer).

Significant Geographic Problems of the Outwash Plains of Southern Michigan.

Outside of the area of the French settlement around Detroit, the first portions of the lower peninsula of Michigan to be occupied were the outwash plains of the southwest. These level, well drained and easily cultivated plains, with their open forest and many small prairies, proved attractive to the pioneer. Little or no clearing was necessary and the soil yielded abundant crops with small effort. Small towns with saw mills and flour mills sprang up to meet the needs of the agri-

cultural population. Roads were few and poor, railroads unknown. Each community, with its village center, was almost if not quite self sufficient.

Since the advent of the railroad, conditions have changed. The towns with strategic locations have shown a steady growth and have developed along industrial lines; the purely community centers, out of touch with main lines of transportation, have shown a steady and persistent decline in population, both relatively and numerically. The early adjustment has disappeared and no readjustment has occurred.

The farming area also suffers from a similar mal-adjustment. The light soil, with its originally sufficient humus content, is now largely incapable of raising satisfactory crops under present farm practice. Each farmer still raises a great variety of crops, not taking into account the great changes in the economic activities of the area, the alteration in transportation facilities and the shifting tendencies of progressive farm practice.

Here we have an area in which a very rapid and satisfactory adjustment to early conditions occurred, but one in which the shift to meet changing economic conditions has not taken place except in very small measure. The population is increasing, but the increase is confined to the industrial centers; the rural population and that of the small towns have shown a persistent and steady decline for the past forty years in the face of the better market for farm products which is afforded by the industrial centers.

Wherein does the future lie for those sections which reached the crest of their wave of prosperity between 1870 and 1880? As to the small town, off main lines of transportation, it is probably doomed and will become of less and less importance and contain fewer inhabitants. The farming area, with its better markets in immediate proximity to the farm, will be obliged to adjust its crops to changed soil conditions, to meet the demands of the industrial centers and the competition of other agricultural areas. Increasing industrialization of the area is bound to occur and with this should go increased prosperity with rational utilization of the land.

W. M. Davis.

Intermont Basins—Read by Title.

Memoir of Frederic P. Gulliver. Printed in full herewith.

Richard E. Dodge.

Geographic Factors in Dairy Farming in Southern New England.

The paper emphasized the change of values of geographic relationships with the changes in New England agriculture. In the earlier days farmers were nearly self sufficient and relied but little upon

outside sources of cattle feed or outside markets. With the development of industrial cities dairy farmers turned from butter and cheese making to the selling of whole milk. Grain acreage decreased, dairy cattle took the place of beef cattle and concentrates became necessary in the dairy ration. This made the area dependent on the west and south for necessary grain for cattle and horse feeding.

With the recent rapid increase in freight rates, grain rose so rapidly in price that farmers in many sections turned again to raising more grain and better hay. The cost of production of milk was thus lowered and the success of new methods warrants our expecting New England dairy farming soon becoming more self sufficient than it has been for the last forty years.

Oliver L. Fassig.

The Trade Winds and Anti-Trades of Porto Rico.

The paper presented an analysis of the trade winds over Porto Rico, based upon daily balloon observations. Charts indicated variations in velocity and direction.

Progress in the Organization of a Climatological Service of the West Indies.

A summary of the purposes of a climatological service to embrace all the islands of the West Indies and portions of the coasts of Central and South America.

V. C. Finch.

The Significance of Vegetable Oils in the Economic Development of the Tropics.

The paper summarized the recent development of commerce in vegetable oils, the present and possible future sources and demand.

F. W. Frostic (Introduced by Carl O. Sauer).

A Geographic Study of the Saginaw Valley as an Area of Gentle Relief.—Read by Title.

W. H. Hobbs.

A Significant Contrast Between the Atlantic and Pacific Coastal Regions.

The recent study of earthquakes from remote stations has proven conclusively that the larger movements of the earth's crust which are now going on have taken place near, though largely inside, the borders of the Pacific Ocean, though there is a strong subordinate zone which

follows the twin plane of the intercontinental seas. Outside these zones the lithosphere surface may be described by contrast as in repose. The contrasted conditions for the Atlantic and Pacific regions are therefore striking.

The process of marine degradation which shapes the continental shelf and, in case of rapid uplift, yields coast terraces, supplies us with a measure for the rate of crustal deformations. Wherever uplift goes on slowly, as it does about the margins of the Atlantic, the treads of the coast terraces are found to be both broad and elaborately eroded by stream action, and the average angle of the terraces is small. Cuestas may be developed. Wherever, on the contrary, uplift is going on rapidly, as it is on the borders of the Pacific area, the treads of coast terraces are narrow and the risers relatively high, the surface of the treads is smooth and but slightly affected by river erosion, and the average angle of the terrace series will be correspondingly large.

Memorial of Robert E. Peary—Printed in full herewith.

R. S. Holway.

Stream and Ocean Terraces in Relation to Recent Earth Movements.

The investigation has been undertaken to determine, if possible, the character and relative amount of recent earth movements in central California over an area approximately 150 by 60 miles in extent including the entire width of the Coast Ranges from the great interior valley to the sea. Santa Cruz marks roughly the northwestern corner of the region being studied.

The measurement of the height of terraces, either stream or ocean, requires the definition of both "terrace level" and baselevel and also the determination of the physical features that identify these levels. Baselevel for ocean terraces is of course sea level, with its usual difficulties of determination, including probably for the upper terraces the question of variation during the glacial period. Baselevel for stream terraces is taken at the low water level of the stream, provided that the stream at the location of the terrace is meandering and very definitely cutting laterally and not noticeably deepening its channel. Such a baselevel is constantly rising in absolute height toward the source of the river. A terrace above a youthful gorge evidently has no determinable height. Theoretically this is also the case with an ocean terrace on an exposed shore, if the sea at that point has not yet made a perceptible cut in the land. "Terrace level" is taken at the surface of corrosion marked by beveled strata in order to eliminate alluvial fill. With ocean terraces this level is measured at the rear of the terrace as the surface of corrosion has always a seaward slope.

With stream terraces the level is taken wherever the beveled strata are exposed for the valley floor of a stream cutting laterally is practically level on a line normal to the axis of the valley.

In some instances stream terraces in the lower course of a river merge into ocean terraces making a self evident correlation of the two. With streams far inland, correlation with ocean terraces is made on the similarity of height above their respective baselevels and on the approximate agreement in the time of standstill of the land during lateral corrosion, as indicated by the relative widths of the terraces.

Thus far in the investigation the data accumulated seem to indicate that at various absolute elevations above sea and in widely separated localities there exist series of three or four stream terraces with a total vertical range of 600—800 feet that may be correlated with each other and with a series of ocean terraces. In some adjoining mountain blocks there seems to be a lack of such agreement in terrace levels. The conclusion that the area being studied has moved substantially as a unit in recent times is suggested but not asserted at the present stage of the investigation.

Ellsworth Huntington.

Memorial of Sumner W. Cushing—Printed in full herewith.

Mark Jefferson.

Chile: A Land Where Immigrants Need Not Apply.

Much of Chile's 290,000 square miles is little available for homes for men. The arid deserts of the north, the rain-soaked forests of the south, and the rough Andine slopes which fill the eastern half of the country for the whole three thousand miles of its length subtract so much from the total area of the country that its 13 people per square mile becomes 156 people to the square mile of usable territory. That is why Chilean agriculture is intensive, with yields per acre greater than elsewhere in America; why the peasant is ill paid, ill fed, landless, and wretched; why immigrants are placed on the land only by ejecting the people of the country, and why fifty years of government-fostered immigration have not brought fifty thousand people to Chile.

W. L. G. Joerg.

Bering's Two Expeditions to Determine the Relation of Asia to America.

A discussion of Bering's two voyages, 1725-30 and 1733-41, in the light of new material, recently found by Professor F. A. Golder in the Russian government archives.

A. K. Lobeck (Introduced by R. H. Whitbeck).

Physiography and Man in Porto Rico.

Porto Rico may be divided into five types of physiographic elements: (1) a central upland; (2) mountain groups above the upland; (3) a piedmont upland at the base of the higher central area; (4) a coastal plain; (5) broad alluvial-covered river flood plains or "playas" near sea level. In the central upland area coffee growing is the most important industry. The mountain groups are wild and uncultivated and are occupied by national forests. The piedmont upland which borders the northern coast supports sugar fields and tobacco. The coastal plain is given over to fruit raising, especially grape fruit and pineapples. In the great playa planis sugar cane is the important crop, every available square foot being devoted to that purpose.

D. T. MacDougall (By Invitation of Council).

The Relation of Plants to New Habitats.

The plan of the implied investigations included the establishment of small experimental areas in four places in which the environmental complexes were widely different, the introduction of species from outside localities, and the exchange of species native to the localities of the experimental plots.

The following statements may be made as to the conditions of dissemination of plants and barriers to distribution:

1. The dissemination of species toward lower levels takes place with facility as the change is from low to higher temperatures, and the actual transportation of seeds or propagules would be aided by air-currents, gravity as making for earth and rock slides, and streams of water. The isolated mountain and desert complexes, however, offer a range of temperatures beyond the capacity for adaptation of all but a few species.

2. An action the reverse of this may be found in the distribution of some of the opuntias; these are preeminently characteristic of the lowlands and of the deserts, but a half dozen species, are represented in the region of the oaks as high as 1,700 meters, while one species extends beyond the oaks and is found among the pines in rocks at 2,300 meters. It was discovered, however, that animals, probably rodents or rabbits, operate a barrage against the movement of other opuntias upward on the mountain slopes, as became evident by some experimental tests in the Mohave desert of California and by repeated introductions at the Xeromontane plantation.

3. It is rarely possible to ascribe the stoppage or restriction of a species to the direct and simple action of a single physical agency.

The actual effect upon one species of defective humidity, low or high temperatures, soil moisture, and other environic components, is dependent upon the intensity or degree of the others together with an allowance for rapidity of variation in these factors as well as time or duration of exposure.

4. Species from cool regions may be more easily established in warm places than the reverse, and montane plants may come to the seashore more easily than the plants of maritime zones may spread over a mountain.

5. Dissemination movements are seen to be freer from regions presenting climatic extremes to more equable climates, as is amply illustrated by the success of so many species from the Atlantic States and Arizona highlands on the Pacific seashore. Possibly the occurrence of the succulent *Opuntia* in Saskatchewan may be considered as an example of this as the predominant feature in dissemination.

6. Not all groups of forms move and adapt themselves to new habitats with the same facility. Thus the species characteristic of desert regions represent an extreme development toward succulence and xerophytism suitable for existence with a lessened water supply, and the retracement of the long way of morphogenic alteration by such species is all but impossible. On the other hand, many mesophytic plants show direct or individual alterations by which they pass into arid areas and maintain themselves for extended periods.

7. The experiments again make it plain that the habitat in which a plant may be found or in which it may have originated may not furnish the most favorable environmental complex, as amply illustrated by the behavior of species that have become weeds. In other words, the fitness of a species for native habitat may not be so close as its fitness for other as yet untried conditions.

George R. Mansfield.

The Geography of Part of Southeastern Idaho—Read by Title.

A mountainous region comprising seven quadrangles with a total area of about 2,200 square miles in the very southeastern corner of Idaho with narrow strips of Utah and Wyoming, has been studied by the United States Geological Survey as a part of its investigation of the western phosphate field. The region lies chiefly in the northern Rocky Mountain province but includes also part of the Basin-and-Range province, both areas being interfingered along their borders with projections of the Snake River lava plain.

The region is underlain by complexly folded and faulted sedimentary rocks, the surface features of which have been determined by later, intermittent uplift, with some warping or gentle folding, and by a series of partial erosion cycles or episodes, of which at least

nine may be distinguished. Normal erosion has been the principal factor in the production of present topography, though climatic change has exercised a clearly distinguishable influence especially in the later stages of topographic development. Lava extrusions both within and without the region have also played an important part in the production of the present surface features.

The semi-arid climate (13-14 inches rainfall) and the prevailing westerly winds exercise a strong control on the distribution of the vegetation. The valley bottoms and windward slopes (5,800 to 7,500 or more feet in elevation), are generally grass or sage-covered. Leeward and higher windward slopes (7,500 to 10,000 feet in elevation) are generally well wooded with aspen, lodge pole pine, Douglas fir and other trees, the last two named being important sources of lumber.

Agriculture and grazing are the chief industries, though phosphate mining promises to assume increasing importance. Frosts, which may occur during any summer month, render the valley bottoms unfit for cultivation. Along the sides of the valleys on slightly higher ground crops of grain, hay and potatoes are raised chiefly under irrigation, but dry farming is assuming increasing importance.

Lawrence Martin.

The Armenian Frontier—Read by Title.

K. C. McMurry (Introduced by H. H. Barrows).

Nashville and the Central Basin of Tennessee.

The growth of Nashville during the past forty years has been slower than that of most of the other important southern cities. Geographic factors have largely controlled this growth. Nashville is the center of the Central Basin of Tennessee, a limestone area very similar to the Bluegrass of Kentucky, almost entirely agricultural and undoubtedly the most productive division of the state.

Nashville is largely a central market and distributing center rather than a manufacturing city. The greater part of its business is with the Basin. Therefore the agricultural growth of the basin is an important controlling factor in the growth of Nashville.

During the past fifty years the agricultural expansion of the Central Basin has been exceedingly slow. Conditions at present are little changed from those of 1880. The same products are raised in much the same way as formerly and a large percentage of the area remains unproductive. In some respects the land has deteriorated rather than advanced. The growth of Nashville has been held back by the static conditions in its most important tributary area.

A new type of agriculture has been developing rapidly in the past

ten years. Dairying and cattle raising are increasing rapidly. A new adaptation is being made to a favorable environment. It is certain that as this type of agriculture increases a much higher productivity and buying power will be developed in the Basin. The result will be a corresponding increase in the prosperity and size of Nashville.

S. J. Novakovsky (Introduced by Ellsworth Huntington).

Geographical Regions of the Fisheries of Asiatic Russia.

The importance of fisheries in economical life of Russia and Siberia.

The amount of fish consumed by the population of Siberia.

General conditions of fisheries in Asiatic-Russia.

Principal geographical regions of fisheries in Asiatic-Russia: 1) Lena-Kolyma; 2) Lake Baikal; 3) Yenise; 4) Obi; 5) Baraba; 6) Aralsk; 7) Amur; 8) Ussuri; 9) South-Western; 10) Nikolayevsk; 11) Sakhalin; 12) Okhotsk; 13) Western Kamchatka; 14) Eastern Kamchatka; 15) Anadyr; 16) Chukotsk; 17) Commodore Island.

Principal causes for slow progress and undevelopment of the Russian fisheries in Siberia (climate, lack of railways, lack of ships, routine methods, rapaciousness, poor policy of the old Russian Government; lack of capital and initiative, low state of culture of the native population, etc.). Rôle played by Japan in the fisheries of Eastern Siberia. The future of Siberian fisheries. Siberian fish as a product for the world's markets.

Alexander G. Ruthven.

Geography in Museums of Zoology.

Museums of Zoology are neglecting to gather the data needed in the study of zoögeographical problems. This is unfortunate for the accumulation of geographic data must be left largely to Museums, and the conditions in nature are being changed rapidly. It is believed that geography should be emphasized, at least to the extent of giving first attention to the securing of data on habits, habitat distribution, and exact range, and that it would be within the scope of legitimate museum activities to provide facilities for investigations in experimental animal ecology.

Carl O. Sauer.

Geography as Regional Economics.

There have been numerous discussions of the scope of geography, and especially there have been examinations of the periphery of the science. Much less attention has been given to the determination of particular objectives within the field of geography. Geography is suffering from a scattering of interests over too broad a field for the limited number of workers engaged in it.

The focussing of attention on certain phases of the field alone appears to give hope of establishing the science solidly. This involves consideration of the content, aims, and methods of such a specific type of inquiry. In this country historical geography has been treated in such a manner.

A voluntary limitation of research by a group of workers to the field of regional economic geography is probably the most urgent need of the science to-day. Regional economics has not been preempted by economic science and belongs most appropriately to geography. The essential problems are 1) the determination of bases of unity of the area, 2) the inquiry into advantages and handicaps inherent in the area, 3) the time element as affecting stage of development, and 4) the analysis of the entire economic complex of the region. It follows that any area, geographically defined, is an appropriate subject of inquiry, and that the inquiry must not be limited to the evaluation of so-called geographic factors.

In the method of research, work needs to be done in forming a scientific discipline for 1) agrogeographic research, as referring to rural conditions, especially the utilization of the land, 2) urban studies, and 3) movement of trade.

A logical as well as pragmatic sanction is at hand for such studies, and by means of them geography may knock successfully at the door of the business world and, as well, it may present itself as an advisor to governmental policy.

Problems of Land Classification—Printed in full herewith.

J. J. Sederholm (Introduced by Lawrence Martin).

Finland as an Independent Republic—Read by Title.

The Grand Duchy of Finland before the world war, its boundaries, topography, geology, hydrography, meteorology, vegetation and fauna; population, industry, commerce, administration, history and culture.

Finland during the world war and its own civil war.

The present Republic of Finland, its boundaries, constitution, politics and economy; relations to neighboring states (a land question, etc.), and to the community of mankind; aspirations for the future.

An Expedition to Urïan Haï—Read by Title.

Situation and history of Urïan Haï. Earlier expeditions. Organization of the author's expedition. Through revolutionary Russia to Minussinsk and over the Saïan Mountains to Bïelotsarsk. Work of the expedition. The southern source tributary of Yenisseï. Tannu Ola mountains. Return along the Yenisseï River on a raft. Through Siberia and Russia at the eve of the Bolshevik revolution.

Soïotes, Mongols and Russian colonists, their languages, customs and inter-relations. Natural resources and future of the country.

Ellen Churchill Semple.

The Grain Trade of Acient Athens—Printed in full herewith.

V. E. Shelford.

Experimental Animal Climatology.

Methods of simulating climatic conditions in the laboratory were illustrated. The effects of climatic factors, temperature, moisture, light, rainfall, barometric pressure, air movement, etc., upon growth, fecundity, and general success or failure of various noxious and useful animals as shown by experiment were discussed. Methods of checking experimental results with field observations, with crop-pest and human death rate statistics, etc., were brought out. The importance of experimentation (a) in determining the kind of weather and climatic records to be made, (b) in the prediction of the rise of insect pests and controlling their numbers, etc., (c) in eliminating errors in conclusions as to factors responsible for various geographic phenomena were stressed.

Forrest Shreve.

Vertical Gradients of Evaporation and Soil Moisture in Desert and Coastal Mountains.

The larger features of plant distribution in arid and semi-arid regions are determined by moisture conditions rather than by conditions of temperature. The rate of evaporation is a measure of the conditions tending to cause the loss of water by plants. The percentage of soil moisture is a measure of the water supply for plants. The ratio of the latter to the former gives a concrete expression of the moisture conditions for plants, and is more significant than the ratio of precipitation to evaporation. The gradients of evaporation and soil moisture have been determined through 5,000 ft. of altitude in the Santa Catalina mountains in southern Arizona, and in the Santa Lucia mountains on the coast of central California. The paper described the contrasting conditions of the two mountains.

Guy C. Smith (By Invitation of Council).

Geographic Influences in Marketing—Illustrated by the Meat Industry.

This paper endeavored to show how geographic conditions have exerted an influence upon our machinery of distribution. First: As related to the problem of middlemen in general, and second: as related to one industry in particular.

The functions of middlemen are rather highly specialized. One of the chief of these functions is that of assembling the products, which becomes necessary for the following reasons:

1. The commodities are produced by small and widely separated producers.
2. They vary so widely in grade and quality that without assembling, it would be impossible to secure the various grades in commercial quantities.
3. They must be transferred to the principal markets where there is a demand for them.
4. They must be assembled for storage because of their seasonal production.

Geographic factors have also been influential in determining where middlemen shall be located, both for the assembling of products locally and in primary markets.

The points at which the grading of products is carried on, as well as the location of storage facilities, are also the result in part of geographic conditions. Seasonal production and storage are closely related to the whole system of buying and selling for future delivery.

The location of live stock markets has been determined by the location of live-stock producing areas of the West in relation to the large consuming population of the East. The average thousand pound steer produces dressed beef weighing about five hundred and fifty pounds. It is more economical to ship dressed beef than it is the live animal.

The seasonal production of lambs makes centralized live stock markets and slaughtering establishments necessary since the source of supply moves from California beginning in April to Virginia, Ontario and the range states in August, and the Middle Western states during the winter and early spring. Small packing plants located in these various sections of production would be very busy for a few weeks and comparatively idle the rest of the year.

Differences in the density of population in different parts of the country have made necessary different methods of distributing the finished products. In the large cities and the thickly populated area of the East, branch houses are the most effective method, while in the more sparsely settled sections of the West the car route method of distribution has been developed.

Refrigeration has been a very important factor in the meat industry in order to overcome the difficulties of distance and temperature.

The supply and the prices of meat products are effectively influenced by the seasons and even by weather conditions.

Eugene Van Cleef.

Rainfall Maps of Latin America, Excepting the West Indies.

Manuscript maps prepared for the Latin-American Division of the "Inquiry" were presented for comment and criticism.

The World's Markets—A Map Based on Natural Regions.

A map for business men in manuscript form, based on the several classifications of Natural Regions, but modified to meet trade needs was presented for criticism.

Stephen S. Visher.

Some Aspects of the Geography of South Dakota—Read by Title.

The boundaries of Dakota were in large part located in respect to streams: the eastern boundary is mostly along the Sioux and the Red rivers; the western boundary is the meridian passing through the mouth of the Yellowstone River; the southern boundary is partly made by the great western bend of the Missouri and is partly along the divide between the White and Niobrara rivers. The northern boundary of South Dakota is approximately halfway between the southern boundary and Canada.

The fact that South Dakota is mostly in the Great Plains where the rainfall is often insufficient for agriculture, and where the rivers are too small for extensive navigation, caused its settlement to be delayed until the land to the east was practically all settled, and until railways furnished an outlet for farm produce. The population of Dakota was only a few thousand until 1875. During the wet years of the early 1880's there was much railway construction and a great influx of settlers, and the population increased to more than 400,000 in 1887, or about two thirds of the present figure. The severe droughts of the late 1880's and the 1890's reduced the population greatly, but it was increased again by good times—wet years—in the 1900's. However drought followed in 1910-12 and the states population in 1915 was less than in 1910.

The character of the native fauna and flora has had important influences. The bison was the chief food of the Indians and the fur trade was the most important source of wealth before 1875, and it has been by no means unimportant since then. The nutritive native grasses, which are cured to natural hay by the dry autumns and which retain their food value throughout the dry winters, are still one of the chief assets of the area. Because of them, grazing is successful even in winter, except when interfered with by the occasional droughts and blizzards. Another resource which has aided stock-raising and settlement in general is the availability of artesian waters. Flowing wells have been obtained at slight expense in much of the state.

The geography of South Dakota is discussed comprehensively in Bull. 8 of the S. D. Geological Survey, Vermilion. S. D., 1918.

R. H. Whitbeck.

Geography and Man in Cuba.

The four hundred years of Cuban history illustrate well the dominant influence of two geographical facts, (1) the insularity of Cuba and (2) its geographical position. It was this geographical position in the belt of the Trades which led to its discovery and colonization by the Spanish whose sailing vessels crossed the ocean in the belt of Trades. The Spanish made no settlements in the belt of the Westerlies, excepting as they penetrated those belts from the region of the Trade Winds. The fact that Cuba remained a Spanish possession long after the colonies on the American continent obtained their independence is the result of its insularity. When one of the colonies on the continent had secured its independence, it gave assistance to others, and thus these colonies successfully threw off Spanish rule. Cuba tried it repeatedly, but none of the former Spanish colonies in America had sufficient sea power to go to the aid of Cuba. It was only when a sea power like the United States came to her assistance that her independence was gained.

Furthermore, Cuba's insularity probably saved the island from being actually a part of the United States. Had the narrow Florida strait not separated Cuba from Florida we doubtless would have taken Cuba when we purchased Florida from Spain. On the other hand, the nearness of Cuba to our own doors was the main reason for our going to her aid in her final struggle for independence. We took little interest in the revolutions in the Philippines until we declared war against Spain on account of Cuba.

The advantage of the geographical position which Cuba possesses comes out again in the great prosperity of the sugar industry. Nowhere else is the cane sugar industry so prosperous or growing so healthily. The reason again is because Cuba lies near the United States, the greatest sugar market in the world and a country with capital for foreign investment. Had Cuba been in the East Indies or off the coast of Africa it would have had no such economic development as it has undergone in recent years. The foreign trade of Cuba is now the largest per capita in the world. The exports of sugar alone reached over $300 per capita in 1920 and foreign trade is more than $400 per capita. Half of the capital invested in the two hundred centrals and their surrounding plantations is American.

Geography and Man at Panama—Read by Title.

The building of the Panama Canal illustrates the interaction of three factors which always operate in human geography. First, the part played by geographical conditions; that is, the earth factor. Second, the part played by man; that is, the human factor. Third, the influence of the particular period of history in which the event took place, that is, the time factor.

Geographical conditions determined the most suitable place for building the Panama Canal, yet the Colombians would probably never have built the canal. The geographical factor was favorable, but the human factor was lacking. The French attempted a canal at Panama at a time when knowledge of sanitation and the perfecting of excavating and other machinery had not reached a stage adequate to so great an undertaking, and the French effort failed. Americans did not undertake the canal until they had reached a certain stage in their own national development and had come to feel the imperative need of the canal and to be sure of their financial and engineering ability to complete it. Our geographical position made it strategically imperative that we, and not any other power, should build and control the canal. Therefore, the construction of the canal between 1904 and 1914 was due to the conjunction of three factors, (1) a favorable site for the canal, (2) a nation that was competent to do the job, and (3) the favorable time for undertaking it.

The canal has cost about 460 million dollars for construction, fortification and operation. About 2,500 ships are now traversing the canal annually and the tolls pay the actual cost of operation but nothing more. The slides still occur but are not as a rule serious. Twenty thousand people are still employed by the Government in the Canal Zone, about seventeen thousand of these being negroes. The Government is doing everything possible to make the canal route attractive and to provide at the canal every facility which passing ships may require.

The people live under a form of paternalistic state socialism, the Government being practically the only property owner and employer in the Zone.

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